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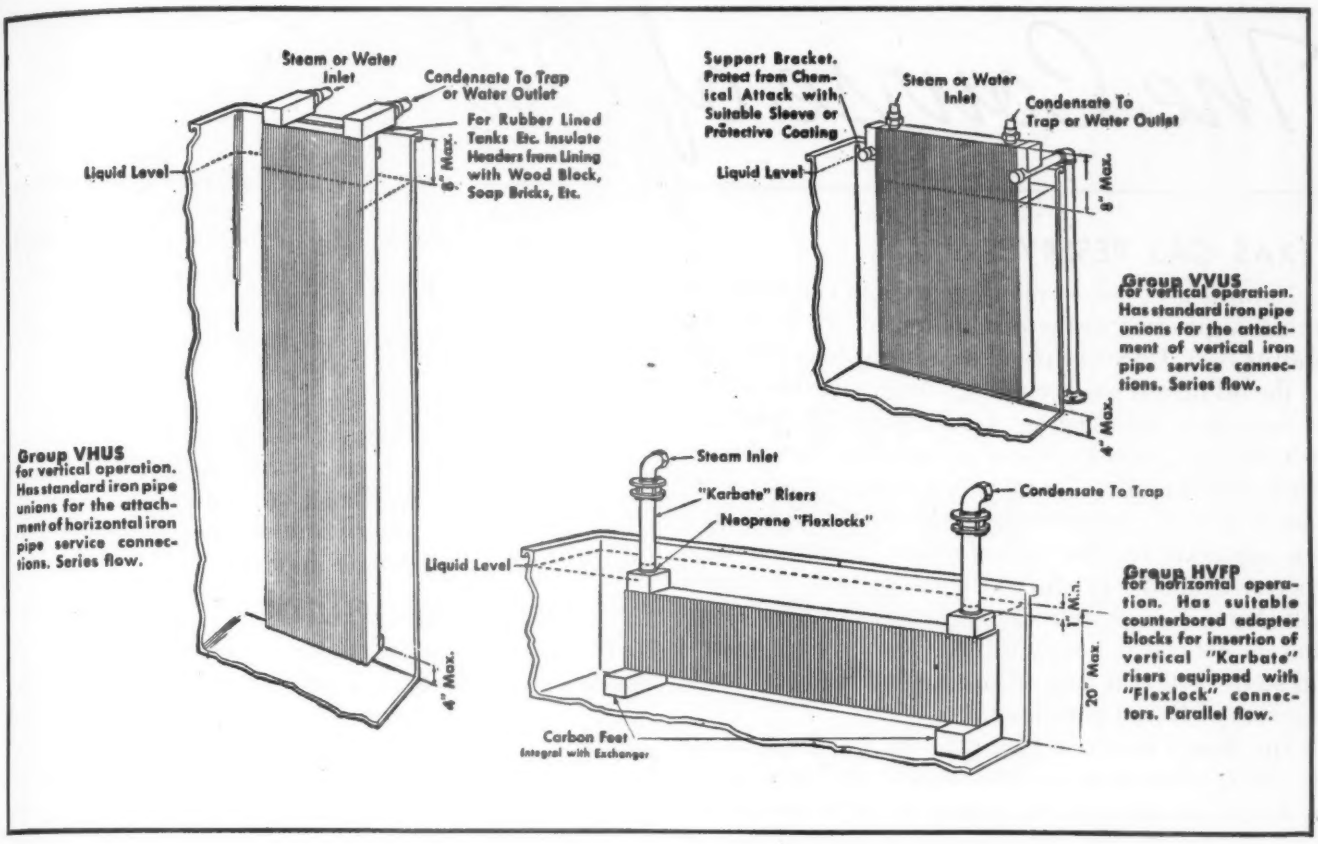
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KEEP YOUR EYE ON THE INFANTRY...THE DOUGHBOY DOES IT!

The Course of Oil

by K. C. SCLATER

TEXAS GAS RESERVES

Natural gas, not so many years ago considered a nuisance product in the production of oil, is coming into its own. Once regarded as a hazardous nuisance by the oil man it has become his most valuable source of energy in bringing the liquid oil to the surface. It looms as a raw hydrocarbon product as valuable as the liquid crude oil with which it is so closely associated. Indeed, the potential uses of natural gas as a raw material for the manufacture of innumerable "petrochemical" products surpasses that of liquid petroleum. Recognition of this fact has focused attention on natural gas reserves of Texas, whose bountiful sources of that natural product are as great as its reserves of liquid petroleum.

The Texas Railroad Commission, in whose hands lie the regulation of oil and natural gas production in Texas, is alive to its responsibilities and to the need for the efficient conservation of natural gas. In a paper discussing the natural gas industry in Texas and what that state is doing about conservation, Jack K. Baumel, who is Director of Production and Chief Engineer of the Oil and Gas Division, Railroad Commission of Texas, says that the "true importance and significance of the gas reserves of Texas are only beginning to be realized. It is becoming increasingly apparent that as we search for oil, what we discover is gas accompanied by more or less oil; that as we go down deeper into the earth, we discover more gas. As a result, *the gas reserves of Texas, despite the great waste of gas in the past, actually approach the oil reserves in magnitude when we compare the two in terms of both heating value and gross tonnage of hydrocarbons.*" (The italics are ours.)

Conservation of natural gas in Texas gives rise to many problems; nevertheless, it has made remarkable progress. Especially is this so with regard to reducing the volume of gas vented to the air. For instance: "venting of gas to the air has been reduced from 384 billion cubic feet, or 37.43 per cent of the gas produced in the state in 1935, to 111 billion cubic feet, or 4.57 per cent of the gas produced in the state during 1944." Figures presented by Baumel from records of the Railroad Commission show that more than "102 billion cubic feet of gas was vented to the air at the gasoline plants during 1944," and that this volume "constituted 92 per cent of the gas vented to the air" during that year.

Considering that there are today 174 counties in Texas that produce oil or gas in substantial quantities, and that these counties include more than 960 oil fields and 825 gas reservoirs; that there are 92 gas fields that contain little or no oil; that each field requires its own special treatment in regard to regulation and operation, the obstacles that confront conservation of natural gas in Texas are "both complex and diverse."

Much has been accomplished in Texas in recent years in gas conservation; still more remains to be done. Hampered as it has been by shortage of skilled help, the work of the Texas Railroad Commission in gas conservation has produced results whose full import will only become apparent years from now.

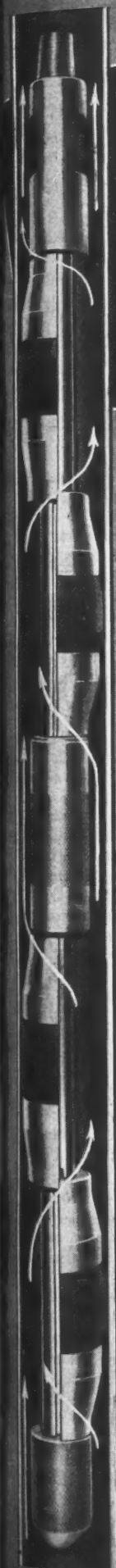
OF "OPERATION PLUTO"

One of the most remarkable engineering feats of the war has just been made public: That of laying undersea pipe lines under the English Channel to supply gasoline to the Allied Forces in Europe. The unique method employed, remarkable for the actual time consumed in laying the lines and the subject of an article elsewhere in this issue, is a heartening demonstration of the heights to which human ingenuity and resourcefulness can reach under the stress of abject necessity. Not only does this accomplishment mark a brilliant chapter in the annals of pipelining, it may also be the inspiration for greater projects in marine pipe line construction and transportation to serve the needs of peace.

MEETING RE-EMPLOYMENT PROBLEMS

A broad enlightened policy with regard to the reemployment of returned service men has been given considerable thought by many oil companies. Here is what the board chairman of a major oil company reported his company was doing to meet that problem. It merits attention.

"Of important current concern to us is the return from the armed services of our employees on military leave. All of you know we have had them deeply in mind during the entire war period and have provided for them in many ways, particularly in providing severance pay and financial support for their dependents. We consider our responsibilities to them, however, to go beyond this. The offering of his original job will not be satisfactory in the case of many of our employees, particularly the younger ones. These young men will have acquired new skills, experience and judgment, which we hope to utilize. Some of the service men are returning with handicaps of one kind or another and we have special plans for these employees so they can become productive members of their communities. I feel we have made constructive plans for the training and reemployment of these men and women."



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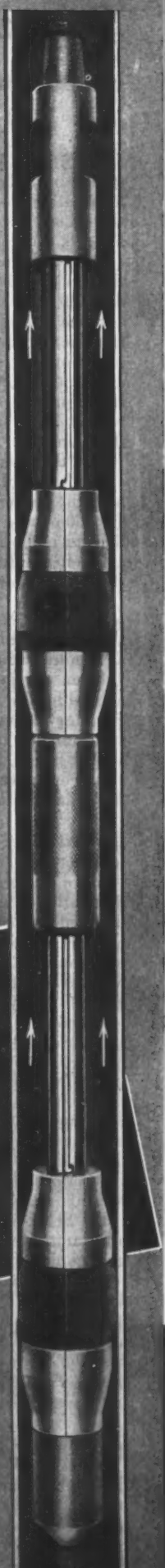

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Scanning WASHINGTON'S OIL HORIZON

MILBURN PETTY

WASHINGTON.— Several operators of 100-octane plants, owned by Defense Plant Corporation, have started preliminary negotiations with DPC to purchase these facilities after the war—now that the government has indicated a willingness to bargain for less than the option price in the contracts.

DPC is hopeful that these negotiations can be completed in time to provide a pattern for other deals when V-J Day arrives and 100-octane requirements are cut back.

Some operators, apparently, don't want to keep their DPC facilities at any price. Arrangements will have to be made for an orderly shutdown of these as soon as 100-octane contracts are cancelled. Other operators are interested in keeping theirs, if the price is right. It has been suggested that DPC continue buying 100-octane from these operators after the war's end, so the plants will not have to be shut down.

But there is opposition in some quarters to such selective cancellation of 100-octane contracts. It is felt that interests of both the government and the industry would be better served if all 100-octane contracts were cancelled simultaneously when the war ends. Then the government could go back to procuring aviation gasoline it needs under competitive bidding.

All this, however, is still in the talk stage here.

● **ROYALTY OIL.** Small refiners will get first call on government royalty oil taken in kind from public lands lessees under a new policy adopted by the Interior Department.

Upon a recommendation from PAW that the crude is not needed for the war program and that transportation is available, Secretary Ickes will order the government royalty oil taken in kind and put up for sale. As all bids are likely to be at OPA ceiling prices, Ickes will then have to make a choice of bidders. First consideration will be given to small refiners under Order 2058, dated May 25, 1945.

● **UNITIZATION.** Look for renewed pressure from PAW to bring about unit operation of certain California oil fields.

More crude is needed for California refineries. It is unlikely that rail movement of West Texas crude will ever reach the authorized level of 50,000 bbl. per day. Present movement is 36,500 bbl. per day but PAW doubts whether West Texas production can continue to maintain it. That brings up the question of whether California's crude output can be increased still more. PAW's policymakers are convinced that unitization can raise production to higher levels in some fields, keep it up there. This view probably will be challenged by some California operators.

● **SYNTHETIC FUELS.** U. S. Bureau of Mines' synthetic fuel research program will go ahead if the $10,000,000 appropriation recommended by the Senate Appropriations Committee is adopted—but there will be a delay in building the demonstration plants, according to W. C. Schroeder, chief of the Bureau's synthetic fuel division. (The Bureau had asked for $13,000,000 but this was cut to $5,000,000 by the House.)

Dr. Schroeder is just back from a tour of German synthetic oil plants. He was with a group of American and British technicians making up the synthetic oil mission. The Germans, he reports, have made numerous improvements in the Fischer-Tropsch and hydrogenation processes not only as used in making synthetic fuels but also in by-products such as lubricating oils and alcohol. The group found blueprints for improvements that the Germans never had a chance to incorporate into their plants. All these data will be made available to American companies as well as used in the Bureau's own research program.

● **CRUDE PRICES.** Another effort is being made to obtain Congress' help in raising OPA ceiling prices on crude oil.

Congressman Patman's Small Business Committee has taken a hand, putting the heat on OPA to recognize replacement costs as a factor in crude price ceilings. Producer representatives blamed OPA's attitude for the small number of returns—less than half up to June 1—of OPA's production cost questionnaires. Deadline for the questionnaire returns has again been extended, to June 30.

The refining cost questionnaire in final draft has been submitted to the refining advisory committee. Since it appeared that the crude cost survey would be inconclusive, the refining group was reluctant to go ahead with this other OPA study, which is to determine a refiner's ability to absorb a crude price advance. But the deadline extension changes the prospect. So, OPA is urging the refining group to hurry up the refining cost study.

● **TIDELANDS.** The federal vs. state tidelands issue is now at the acute stage.

A month ago, California oil men felt quite confident that the threat of federal claims to offshore submerged lands was remote. Secretary Ickes had backed away from granting a "public lands" lease on these lands, deferring to a Department of Justice suit. But there was widespread belief that President Truman was opposed to such a suit. Moreover, support was building up in Congress for the quitclaim resolutions that would declare the states owned these lands.

Suddenly, Attorney General Biddle filed suit against Pacific Western Oil Corporation, claiming submerged oil lands off Santa Barbara, California, and seeking to enjoin further production by this operator who held a state lease. But oil men were really shocked at President Truman's statement that he had told the Attorney General to file the suit.

This shift in the wind means a rough passage for the quitclaim resolutions, especially in the Senate. But Biddle's statement that the Califonia suit may also establish federal claims to submerged offshore lands will arouse coastal states to fight.

● **TRANSPORTATION.** With no tankers delivering products to the East Coast area north of Cape Hatteras and only 100,000 bbl. per day of crude coming up from the Gulf by boat, overland transportation facilities will continue to be used to their utmost. Besides the eastern movement, rail shipments to the West Coast will continue at or above 200,000 bbl. per day. That means a tight transportation situation throughout this summer and into next winter, or until the Japs fold up.

● **INTANGIBLE DEDUCTIONS.** Treasury Department has served notice that it still wants Congress to repeal the option to charge intangible drilling and development costs to expense. This was disclosed when the Treasury reported on pending bills to incorporate this option into the basic tax law, introduced after the New Orleans' circuit court had invalidated this regulation in the F. H. E. Oil Co. case. (Later, the same court backed down on this.) Treasury said it was not "opposed" to these bills provided the option does not apply to any year after 1945.

● **WORLD OIL.** Worldwide oil production is just about in balance with refining capacity. During 1944, the crude supply available to the United Nations group, including Russia, averaged 6,887,000 bbl. per day while refining capacity totaled about 7,400,000 bbl. per day on January 1, 1945. That means the on-stream capacity was about equal to the crude production.

Caribbean area production last year averaged nearly 1,000,000 bbl. per day of which about 700,000 came from Venezuela (now up to around 850,000 bbl. per day), 100,000 from Colombia and a like amount from Trinidad. The Persian Gulf area accounted for about 430,000 bbl. per day in 1944, including 278,000 from Iran (now up to about 350,000 bbl. per day).

South American refining capacity totaled about 778,000 bbl. per day, of which 550,000 was in the Netherlands West Indies off Venezuela. Middle East refining capacity totals about 500,000, including 315,000 bbl. per day at Abadan on the Persian Gulf and 80,000 bbl. per day at Haifa at the southern terminus of the Iraq pipe line.

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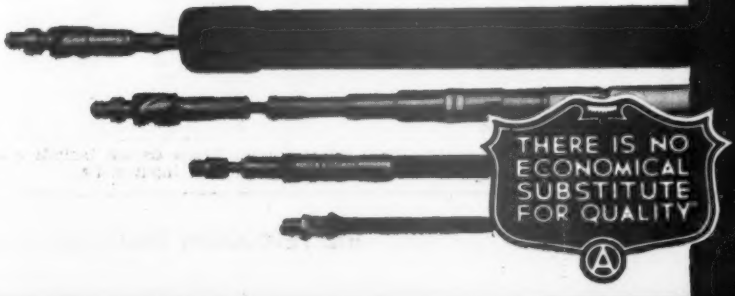

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DEEP WELL PLUNGER PUMPS

AND SUCKER RODS

National Petroleum Situation

DRILLING MOVES UPWARD. May drilling operations reached a new high rate of 2325 wells, which is approximately the average level recorded in 1940-41. The May rate is 301 wells greater than the monthly average shown in the first four months of this year.

YEAR'S QUOTA ATTAINABLE. Drilling results in the first five months of this year were only 7 per cent behind the projected program. To date, the industry completed 10,432 holes, against the five months quota of 11,170. With successful efforts of PAW to provide necessary materials and urgent efforts of operators to stake more locations and put more rigs in operation, it is confidently expected that this year's quota of 27,000 drill-holes will be attained.

MORE WILDCATTING NEEDED. The only adverse factor in the current drilling picture is the continued lag in wildcat operations. Results for the first five months show that these were 21 per cent below expectancy. The quota for the period was 2068, whereas the industry only drilled 1628. Yet, if the industry drills an average of 339 wildcats a month over the balance of the year, the 1945 quota of 5000 exploratory holes can be met.

MOTOR FUEL PEAK. A new high record in demand for motor fuel was reached in May with a daily average of 2,473,000 bbl. In the first five months of this year the demand for motor fuel showed an increase of nearly 17 per cent over last year. Increased ration quota for civilians, prospect of some 200,000 new automobiles this year, coupled with continued heavy war requirements, will bring further gains in demand over next three months.

HEAVY STOCK WITHDRAWALS. Increased demand for refined products in May resulted in substantial inventory reductions. Motor fuel stocks were cut nearly 7,000,000 bbl., while stocks of all fuel oils dropped 2,600,000 bbl. All refined stocks showed a reduction of about 12,400,000 bbl. The industry's stock combined position on June 1 is about 22 per cent below required working levels. However, war requirements offer little opportunity for replenishment of depleted inventories.

CRUDE NEEDS TOP 5 MILLION. For the first time in its history the oil industry met a demand for crude oil of more than 5,000,000 bbl. daily. Total demand in May was about 156,220,000 bbl., a daily average of 5,039,000 bbl. Demand exceeded domestic production by about 154,000 bbl. daily. Except for the relatively small withdrawal of crude from storage, the excess demand over domestic output was supplied by foreign oil.

Comparative Statistics, May, 1945

*All figures are computed on a Bureau of Mines basis.**

	May 1945(p)	April 1945(p)	May 1944	This year to date	Last year to date	Per cent change
Wells drilling	4,280	4,150	3,757	4,280	3,757	+14
Total wells drilled	2,325	2,169	1,727	10,432	8,067	+29
Development wells	1,976	1,849	1,418	8,804	6,648	+32
Oil	1,217	1,123	1,006	5,417	4,666	+16
Gas	208	219	162	959	760	+26
Dry	551	507	250	2,428	1,222	+99
Per cent dry	28.0	27.4	17.6	27.6	18.4	+ 9.2
Wildcat wells	349	320	309	1,628	1,419	+15
Oil	49	38	27	237	172	+38
Gas	11	8	7	53	46	+15
Dry	289	274	275	1,338	1,201	+11
Per cent dry	82.8	85.6	89.0	82.2	84.6	— 2.4
Crude production	151,440	144,100	141,293	724,722	590,040	+23
Daily average	4,885	4,803	4,558	4,799	3,908	
Crude demand†	156,220	¶148,890	145,234	745,360	698,473	+ 7
Daily average	5,039	4,963	4,685	4,936	4,656	
Crude stocks	228,870	229,100	241,430	228,070	241,430	— 6
Days supply	45	46	52	45	52	
Natural gasoline production	9,630	9,115	8,477	46,624	40,541	+15
Daily average	311	304	273	309	270	
Motor fuel production	69,800	65,100	61,191	333,020	294,391	+13
Daily average	2,252	2,170	1,974	2,205	1,963	
Gasoline yield, per cent	40.2	40.0	38.6	39.7	37.3	+ 2.4
Motor fuel demand	76,670	69,425	63,087	331,791	283,799	+17
Daily average	2,473	2,314	2,035	2,197	1,892	
Motor fuel stocks	81,030	87,900	78,955	81,030	78,955	+ 3
Days supply	33	38	39	33	39	
Fuel oil production	62,870	61,300	59,241	304,201	288,537	+ 5
Daily average	2,028	2,043	1,911	2,015	1,924	
Fuel oil demand	67,600	63,750	58,686	344,592	323,995	+ 6
Daily average	2,180	2,125	1,893	2,282	2,160	
Fuel oil stocks	59,720	62,350	77,372	59,720	77,372	—23
Days supply	27	29	41	27	41	
Refinery still runs	150,270	143,350	139,537	719,858	669,923	+ 7
Daily average	4,847	4,778	4,501	4,767	4,466	
All refined stocks	206,900	¶219,365	229,732	206,900	229,732	—10
Days supply	36	41	48	36	48	

*Unless otherwise stated all figures represent thousands of barrels. †Domestic and foreign. ¶Revised.

Economic Position of U. S. Petroleum Industry

Four months ending May, 1945

	Normal	Actual	Per cent of normal
Drilling*** (wells completed)	11,170	10,432	93
Production (daily crude output)	4,900	4,799	98
Refining (daily still runs)	4,860	4,767	98
Stocks (crude and refined)	558,000	435,770	78
Price of crude (per bbl.)	$1.99	$1.22	61

Crude Prices by States for May, 1945§

U. S. average	$1.22	Louisiana	$1.20
Texas	1.23	Arkansas	1.25
California	1.07	New Mexico	1.04
Oklahoma	1.17	Mississippi	1.10
Kansas	1.17	Illinois	1.37
		Other States	1.89

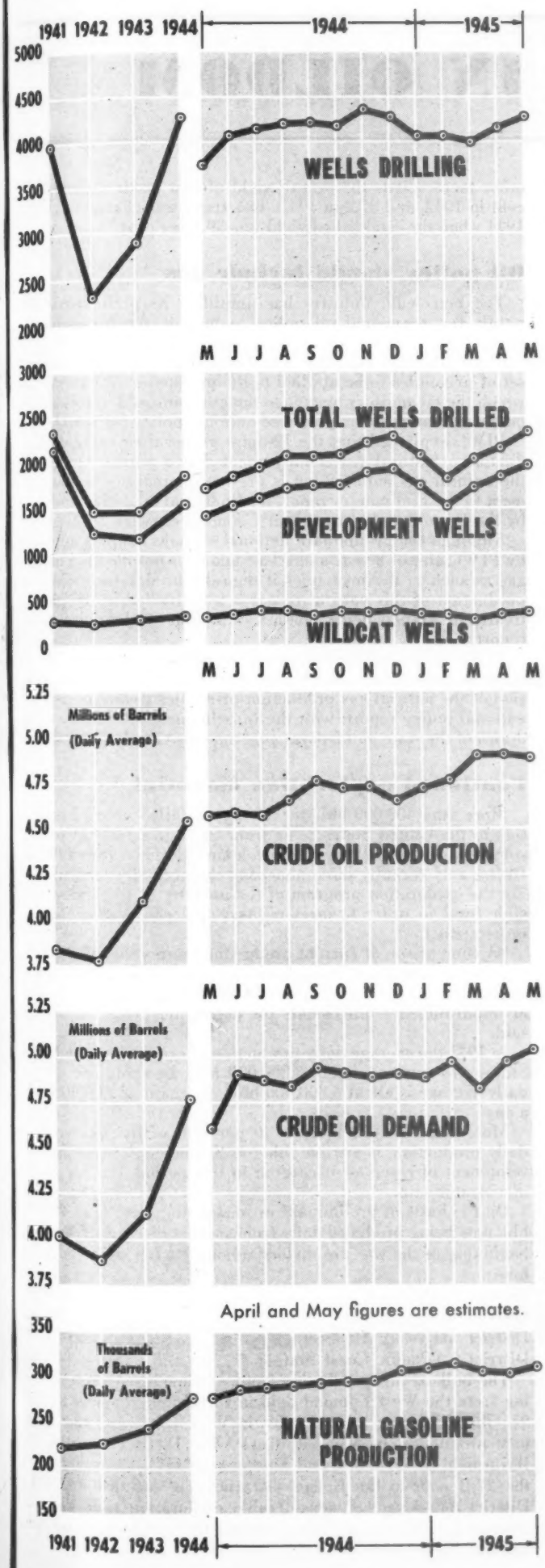
Basic crude prices

Oklahoma Kansas (36 gr.)	$1.17
Texas Gulf Coast (36 gr.)	1.40
East Texas	1.25
West Texas (36 gr.)	1.04
Calif. Signal Hill (26 gr.)	1.11
Pennsylvania Bradford	3.00

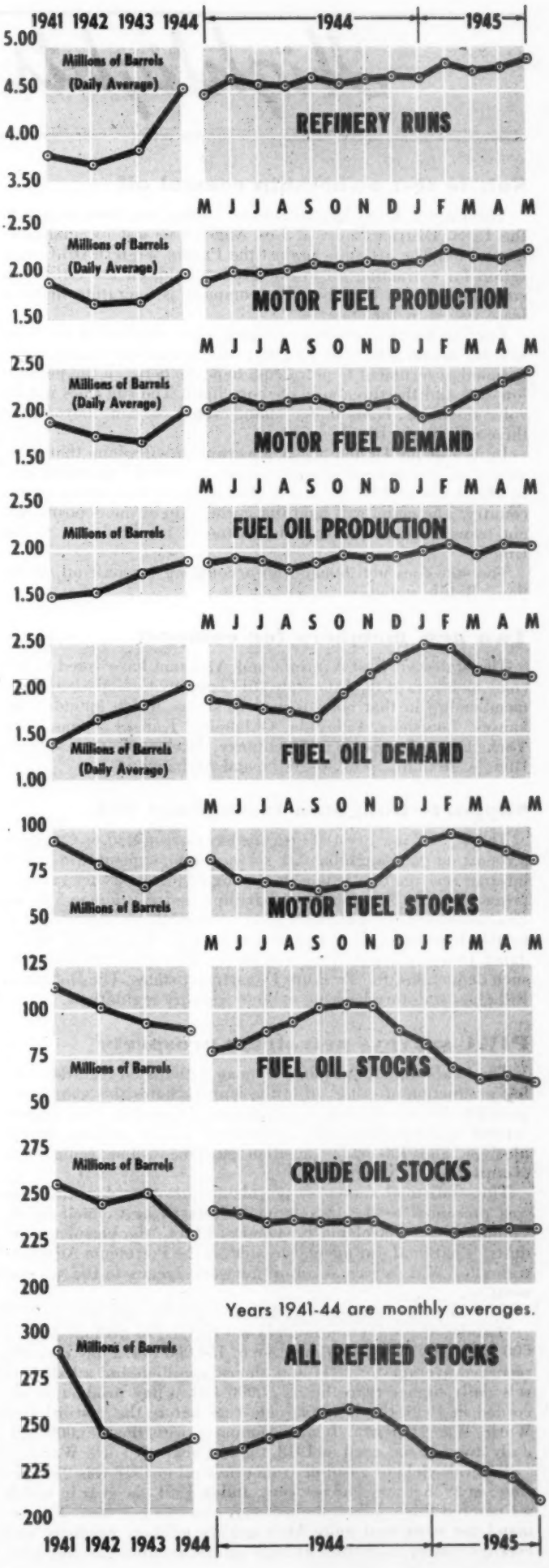
Drilling and Production Statistics by States

	May 1945(p)	April 1945(p)	May 1944	This year to date	Last year to date	Per cent change
Total wells drilled	2,325	2,169	1,727	10,432	8,067	+ 29
Texas	607	633	518	2,875	2,113	+ 36
California	192	196	158	968	789	+ 23
Oklahoma	220	191	137	954	611	+ 56
Kansas	152	128	126	638	669	— 5
Louisiana	86	91	70	424	290	+ 46
Arkansas	24	13	30	64	107	— 40
New Mexico	29	43	39	190	175	+ 9
Mississippi	33	32	7	140	51	+175
Illinois	154	101	122	639	635	+ 1
Other states	828	741	520	3,540	2,627	+ 35
Wildcats drilled	349	320	309	1,628	1,419	+ 15
Texas	121	143	111	660	526	+ 25
California	15	18	17	88	75	+ 17
Oklahoma	58	23	31	180	129	+ 40
Kansas	39	27	43	147	194	— 24
Louisiana	13	13	10	66	60	+ 10
Arkansas	7	1	7	20	28	— 29
New Mexico	4	7	10	30	33	— 9
Mississippi	5	14	7	52	36	+ 44
Illinois	25	23	24	118	116	+ 2
Other states	62	51	49	267	222	+ 20
Daily crude production	4,885	4,803	4,558	4,799	4,509	+ 6
Texas	2,193	2,180	2,033	2,172	1,962	+ 11
California	932	910	835	907	837	+ 8
Oklahoma	387	355	338	368	338	+ 9
Kansas	277	264	278	270	275	— 2
Louisiana	360	360	356	355	358	— 1
Arkansas	79	79	80	80	81	— 1
New Mexico	105	106	109	105	114	— 8
Mississippi	51	53	40	51	42	+ 21
Illinois	210	203	213	207	219	— 5
Other states	291	293	276	284	283	0

§No change since prices frozen. Prices do not include subsidies. (p) Preliminary. ***Does not include input wells.



April and May figures are estimates.



Years 1941-44 are monthly averages.

Highlights IN OILDOM

Suit to test ownership coastal oil

The United States Department of Justice has brought suit in the U. S. District Court at Los Angeles to test ownership of coastal oil. The action is against the Pacific Western Oil Corporation for extracting oil in the Elwood field, off the California coast near Santa Barbara. The company is operating under a lease issued by the state.

Francis Biddle, attorney general, who announced the suit, said the action is to serve as a test case to establish rights of the national government to petroleum deposits between the point of low tide and the three-mile offshore limit. The suit does not involve tidelands, lands under inland waters, or land beyond the three-mile limit, Biddle said.

In its suit the United States government will claim that it acquired all submerged deposits in the so-called "marginal sea" by the treaty of 1848 in which Mexico ceded California to this country. The claim will hold that ownership of the deposits was not transferred to the state by virtue of its admission to the Union.

The suit does not demand an accounting for past oil operations, Biddle stated.

Two new members for compact

The states of West Virginia and Alabama have voted to become members of the Interstate Oil Company Commission. Total membership in that body is now 16 states, which includes Arkansas, Louisiana, Colorado, Oklahoma, Kansas, Texas, New York, Pennsylvania, Ohio, Kentucky, Michigan, New Mexico, Illinois, Montana, West Virginia, and Alabama.

Supports Doughton intangibles bill

The U. S. Treasury Department has transmitted to Congress a report on the Doughton Bill, asking for enactment into law of internal revenue regulations governing deductibility for tax purposes of intangible oil and gas drilling and development costs. Enactment of the regulations would correct the problem created by the decision of the Circuit Court at New Orleans that invalidated treasury regulations permitting oil companies to make such deductions, the Treasury Department states. The Doughton Bill gives statutory backing to these treasury regulations.

PIWC surveys petroleum prospects

The total output of gasoline from an anticipated record-breaking production of crude oil in the United States this year is expected to be only slightly less than that obtained in 1944 despite further increased demands for synthetic rubber, toluene for explosives, and 100-octane aviation gasoline, which reduce the overall gasoline yields.

This statistical survey of petroleum prospects for this year was presented to the Petroleum Industry War Council by its Committee on Petroleum Economics. PIWC, the petroleum industry's national war agency created by the Petroleum Administrator for War, serves as an oil advisory agency to the government.

The committee report to PIWC said:

"Crude oil production in 1945 is expected to average 4,737,000 bbl. daily. This is an increase of 150,000 bbl. a day over the recorded average for 1944 and almost a million and a half barrels daily higher than the 3,327,000 bbl. a day production recorded in 1938, the last complete year before the hostilities of World War II began. It also compares with the 975,000 bbl. daily average recorded in 1918, the last year of World War I.

"Overall yield of gasoline from crude oil in 1918 was 25.3 per cent; in 1938 it was 44.3 per cent, and in 1941, the year in which we entered this conflict, the average was 44.2 per cent. The demand for more and more high quality military products and ever-increasing quantities of high octane aviation gasoline plus other factors, cuts the overall yield of that product to 39.8 per cent in 1942, and 37.2 in 1943. This trend was changed again in 1944 when the established yield was 39.4 per cent."

Oil policy should include gas

The petroleum industry has amplified its preliminary proposals for a national oil policy to include the production of natural gas.

The Petroleum Industry War Council has approved a broad set of principles to be applied to the production of natural gas, which the oil advisory agency to the government declares should be incorporated in any proposed national policy for petroleum.

PIWC explained that the 12-point proposal covering the production of natural gas is not projected as a separate policy for the natural gas industry but is presented precisely as a supplement to the preliminary report on a national oil policy approved by the Petroleum Industry War Council February 28, 1944.

Although the preliminary national oil policy report approved by PIWC almost a year and a half ago does not mention natural gas as such in the principles it then declared, nevertheless the production of this natural resource is embodied in the general treatment of petroleum contained in that preliminary policy report.

PIWC expressed the belief that the public welfare and the interest of the oil and gas industry will be furthered by the inclusion of the natural gas production principles in the preliminary national policy report, with the jurisdictions, functions and the duties of the state and federal governments clearly defined.

Continued exploration essential

More than 400,000 bbl. of the current daily crude oil production in the United States come from fields and pools discovered since Pearl Harbor, Deputy Petroleum Administrator Ralph K. Davies said recently in emphasizing the necessity for maintaining the exploration program of the industry at the highest possible level in order to meet military and essential civilian requirements.

"A comparison of current production figures with those of the year preceding Pearl Harbor discloses the vital importance of continuing all-out exploration for new oil sources at this time of unparalleled requirements for petroleum products," Davies said.

In 1941 the average daily production of crude oil in the United States was approximately 3,800,000 bbl., he said. The current daily average is about 4,800,000 bbl., or a gain of 1,000,000 bbl. a day.

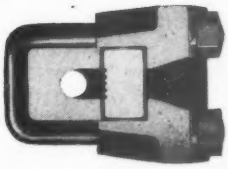
More than 400,000 bbl., or 40 per cent of the total gain in daily production, is attributable to wartime exploration and development of reserves discovered in this period, the deputy administrator said.

On the basis of preliminary estimates, the more than 400,000 bbl. now being produced daily from sources discovered since the beginning of the war are divided among PAW's districts as follows:

District 2 (Midwest)	200,000 bbl.
District 3 (Southwest)	155,000 bbl.
District 4 (Rocky Mt. States)	12,000 bbl.
District 5 (Pacific Coast States)	35,000 bbl.

The bulk of this production from wartime discoveries is coming from the West Edmond field in Oklahoma (PAW's District 2); the Ellenburger Lime pools in West Texas and the recent new production in Mississippi (PAW's District 3); the Elk Basin field in Wyoming and Montana (PAW's District 4), and the 27-B pool in the Buena Vista field in California (PAW's District 5). Although considerable exploration took place in District 1 (East Coast States) during the last 3 years, no commercial discoveries of oil were made.

Alike in Quality



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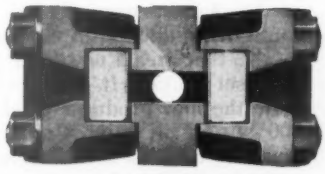

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PENBERTHY PRODUCTS

MAJOR *Oil Field* ACTIVITIES

● **LOUISIANA.** Shell Oil Company, Inc., has completed two deep gas discoveries in Louisiana. No. 1 Louisiana Central Oil and Gas Company, 31-15n-3e, northwestern Caldwell Parish, was completed for 9,600,000 cu. ft. of gas daily through casing perforations in the pay from 9510-84 ft. The discovery was drilled to 11,615 ft. and casing set on the bottom of the hole for completion. No. 1 Tremont Lumber Company, 22-15n-1w, Chatham area of Jackson Parish, showed for an estimated 10,000,000 cu. ft. of gas daily. The producing formation is from 9584-9620 ft. Shell is reported to be planning another wildcat about 1 mile east of this well.

● **KANSAS.** Westgate-Greenland Oil Company has opened a new pool in Salina County with No. 1 Prescott, NW SE SW, 17-14-2w, two miles north of the discovery well in Salina pool. It has been completed for 245 bbl. of oil daily from the Viola lime at 3238-53 ft.

Derby Oil Company has a possible pool opener with No. 1 Rogg, SE SE SW, 7-13-14w, Russell County. The pool is 1½ miles north of production in the Atherton pool. In preliminary swabbing tests the Rogg made 115 bbl. of oil in 3 hours from the Arbuckle lime at 3195-3200 ft.

Sedgwick County has a new pool opener with Fulton and Turner's No. 1 Hohn, NW NW SW, 22-27-1w, 2 miles west of the city limits of Wichita. Operators estimate the well good for 100 bbl. of oil natural from the Kansas City lime at 2817-27 ft.

● **OKLAHOMA.** One of the most important oil developments in the Mid-Continent in several years is the discovery of Second Wilcox sand, a solidly saturated sand of great thickness, in the Ramsey pool, Payne County. Mid-Continent Petroleum Corporation had established a daily potential of 7697 bbl. of oil with the No. 3 Columbia, NW NE SW, 18-18-2, before deepening to the Second Wilcox. There are 50 oil wells in the Ramsey pool producing from the First Wilcox and the Hunton Lime. This is the first well to produce from the Second Wilcox.

Another deep oil field in southern McClain County is looming following a drillstem test that showed oil and gas at the Cities Service Oil Company and others No. 1 Lawson, C SW NE, 22-5-4w. The well, north of Lindsay, had reached a total depth of 9959 ft., upper Simpson sand. On an early test the well blew gas with a spray of oil for about 10 to 15 minutes. It was shut down to await further orders.

The Continental Oil Company with Sinclair Prairie Oil Company have given central Osage County another producing area. The well is No. 1-3 Osage, SE SW NE, 7-23-9e. Located between the Manion, North Manion and Bandwheel pools, the well picked up oil sand from 2110-66 ft. It was completed for 98 bbl. of oil per day.

● **TEXAS.** Sinclair Prairie Oil Company has opened a gas-condensate pool for Colorado County with its No. 1 Felix Fehrenkamp. Located 2½ miles southeast of Rock Island, the well is bottomed at 11,000 ft. It has been completed for 6,000,000 cu. ft. of gas daily.

No. 1 Seekamp and Palmer of Sterling Oil and Refining Company has opened a new producer for Lavaca County. Completed for 29,000,000 cu. ft. of gas daily together with 84 bbl. of condensate, the well is producing through perforations from 7700-50 ft.

The Gulf Coast has another oil pool with the opening of the Glenn H. McCarthy No. 1 Smith, 9 miles northwest of Angleton, Brazoria County. The discovery flowed 30 bbl. of 36-gravity oil an hour through perforations from 8656-61 ft. Production is from the Frio sand.

Chamlette Petroleum Corporation No. 1 Lake Shore, 24-A26-PSL, between the Fullerton and Union pools, northwestern Andrews County, opens a new pool for that area. Production is from the San Andres, upper Permian. It flows 33 bbl. of oil an hour.

J. D. Hancock topped pay at 2950 ft. in No. 1 Bouscaren, 29-GG, 1½ miles south of production in Crockett County, to give that area a new field. Casing has been set at 3500 ft. and field men estimate the new producer good for 200 to 300 bbl. of oil daily. Production is believed to be from the Clearfork sand.

Amerada Petroleum Corporation has opened a new deep pool for northwestern Gaines County with its No. 1-A Jones, 3-A6-PSL. Situated 7 miles northwest of the Russell deep Permian pool, the well produces from 9085-1942 ft. oil and oil-cut mud. Operators believe the test is still in the basal Permian.

One of the most prolific pays in the West Texas Permian basin is indicated for Winkler County in the Keystone pool. The well, found by the Gulf Oil Corporation, opens the eighth pay zone for the field. It is the Waddell sand in the Simpson, middle Ordovician section. On a one-hour drill stem test the producer, No. 60 E. Keystone, flowed 6,163,000 cu. ft. daily of gas from 8745-8811 ft.

The Iglehart area of Colorado County, upper Texas Gulf Coast, was opened to gas-condensate production by the Shell Oil Company, Inc. No. 1 Kyle flowing 62 bbl. of 52-gravity condensate and 12 bbl. of salt water in 24 hours is the producer. The producing formation is from 8780-90 ft.

Southern Archer County, North Texas, has a new Caddo lime oil pool with No. 1 Banson, opened by L. T. Burns of Wichita Falls, Texas. With total depth of 4612 ft. and top of pay zone at 9453 ft., the well was completed to pump 71 bbl. of 42-gravity oil in 24 hours.

Sinclair Prairie Oil Company has opened a new gas-condensate pool in Colorado County, with a dual completion in its No. 1 Gordon. The well was completed for 41.4 bbl. of condensate with 2,550,000 cu. ft. gas daily from upper pay at 8462-82 ft. and for 119.3 bbl. of condensate and 7,100,000 cu. ft. of gas daily from the lower pay from 8847-8917 ft. Total depth of the well is 11,714 ft.

● **INDIANA.** In Knox County, about 6 miles southwest of Vincennes, William P. Muller et al have a good producer in No. 1 Frank Ruppel. The producer is in the NE SW SE, 36-2n-11w. The pay is in the McClosky limestone from 1823-33 ft. with total depth at 1833 ft. Operators are reported to be expecting to acidize and should complete the test for 200 to 500 bbl. of oil per day. The test is near the St. Thomas pool and is the best well in the area.

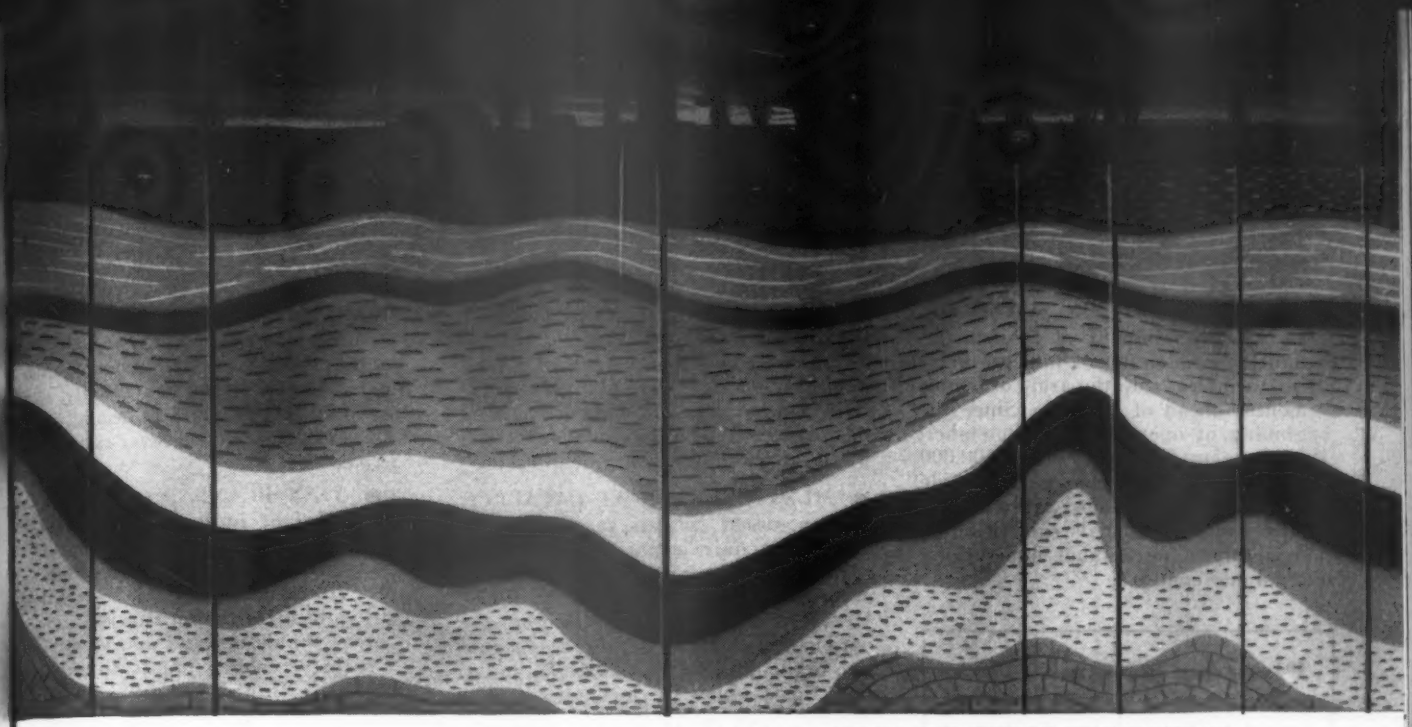
● **KENTUCKY.** Sinclair Prairie Oil Company and associates have opened a new oil area in Webster County, western Kentucky, with No. 1 Cavanaugh, SW NE NE, 12-N-23. The producer is ¾ of a mile west of production, and opens a new pay section for that area. It has the Tar Springs sand at 1944 ft.

The J. W. "Red" Carter and Sallee Brothers No. 1 Liles, 21-0-22, Union County, is indicating an excellent oil producer in the Cypress sand. The well made 15 bbl. of oil an hour on initial test from 2289-2301 ft. The wildcat is situated a mile south of the village of Dixie and 2½ miles from other oil producing wells in the area.

About 2 miles east of Corydon and 5 miles southwest of Henderson, Henderson County, F. J. "Francis" Fleming and A. K. Swann have opened an oil pool with No. 1 Dave M. Patterson. The pay is the Cypress sand, 2265-72 ft. On the first 12-hour test the well made 100 bbl. of oil. Producers believe it will be completed for about 185 bbl. per day.

● **ILLINOIS.** Beull and Doran's No. 1 Martha Young, 12-2N-1E, has been completed in the Cypress sand at 1754-61 ft. for 85 bbl. of oil daily. The wildcat is a mile northwest of Odin and is a mile from the nearest production.

T. Blake Dirickson and associates appear to be giving the McLeansboro area of Hamilton County, southern Illinois, a new oil field with their No. 1 Pressley, C SW SW, 5-6s-6e. The well had the Aux Vases sand at 3091 ft. At 3117 ft. tests indicated the well to be good for about 200 bbl. a day. Oil men termed it one of the best looking showings for southern Illinois this year.



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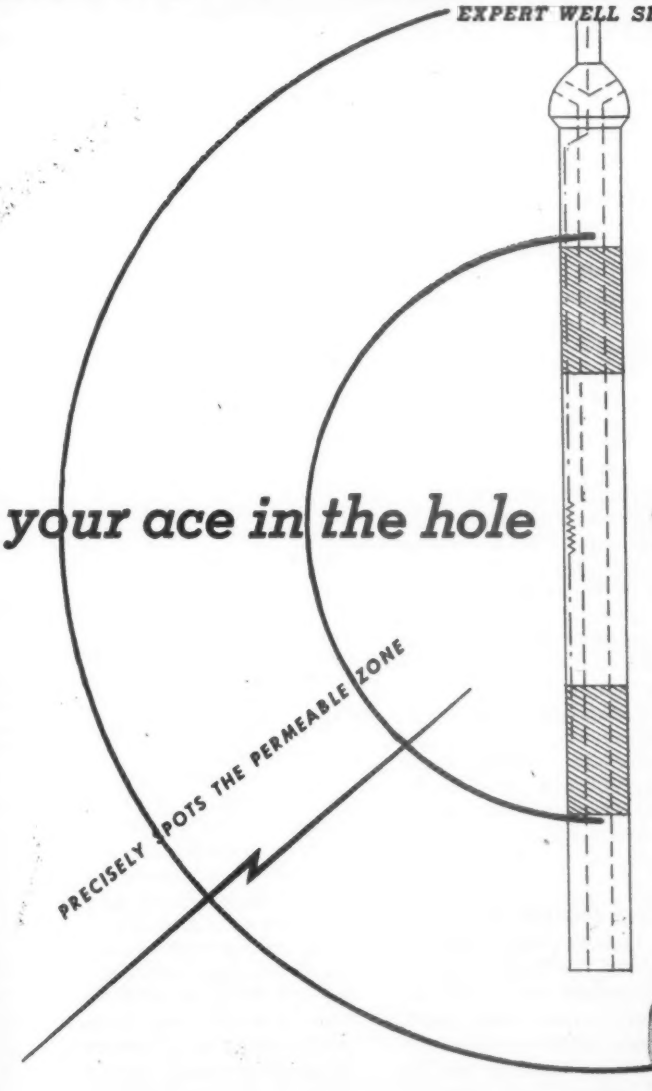

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MAJOR *Refining* ACTIVITIES

● **PLANT AHEAD OF SCHEDULE.** Standard Oil Company of Indiana has completed production of toluene under its first contract with the army ordnance 9 months ahead of schedule. Since the beginning of operations in September, 1943, the plant has turned out 29,500,000 gal. of toluene. This is enough to provide the "T" for TNT in almost half a million bombs, company officials said. Production is continuing without interruption under a new contract.

Plant on stream

The pressure maintenance and liquid hydrocarbon extraction plant of the Haynesville Operators' Committee at Haynesville, Louisiana, designed to recover daily 16,000 gal. of natural gasoline, 10,000 gal. of butane, and 4000 gal. of isopentane from gas produced with 6000 bbl. of oil a day, has started runs. Dry gas is reinjected into the producing zones. Speakers at the dedication of the plant estimated that from 6,000,000 to 8,000,000 bbl. of oil would be added to the ultimate recovery from the field by this method.

● **THIRD FURNACE ON STREAM.** The third furnace at the Sunray Oil Corporation refinery, Allen, Oklahoma, is now on stream and is resulting in a material increase in capacity for the modern plant. F. L. Martin, vice president in charge of Sunray refining, says the new furnace and other equipment were installed at a cost of nearly $500,000, and as a result cracking capacity is increased to 5500 bbl. and daily crude yield to 12,000 bbl. Only one other plant has been built with the 3-furnace design. It was engineered by Universal Oil Products Company and is on Curacao, Netherlands West Indies.

● **OIL SHALE PLANT.** Completion of rights-of-way surveys and maps, office building plans and specifications, and water and power system designs, are announced by Dr. R. R. Sayers, director of the U. S. Bureau of Mines, for the oil shale demonstration plant to be built near Rifle, Colorado. The $1,500,000 plant to be operated jointly with an oil shale research and development laboratory at Laramie, Wyoming, will serve as a proving ground for processes being developed to convert the nation's reserves of oil shale into an auxiliary source of liquid fuels and lubricants. The demonstration plant and mine will be established on the United States naval oil shale reserves. The grazing service has begun construction of a truck trail nearly 8 miles long from the plant site to the mine. One of the major installations at the plant will be a 1½-mile-long tramway to carry shale from mine to plant.

● **MUST OPERATE AT CAPACITY.** The increased civilian gasoline allowance will require capacity operation of refining facilities of the United Nations, according to an announcement by PAW. Heavy withdrawals have reduced the national gasoline stockpile, the exception to the downward trend being on the East Coast where the inventory has increased, PAW said.

"The refining capacity not only of the United States but of the United Nations, must be operated at capacity to make good the increased rations," the report said. "This, despite the changes in military requirements resulting from the end of the war in Europe."

● **BILLIONTH GALLONS.** Standard of California is the first western oil company to produce its billionth gallon of 100-octane gasoline, President H. D. Collier, has announced. One billion gallons of this fuel, it is estimated, would fuel more than 22,000 B-29 Superforts for a trip around the world under average circumstances. Indicative of the vast strides in production is the fact that just one refinery unit now turns out daily nearly five times the amount of 100-octane Standard produced in the entire year of 1937 when quantity output began.

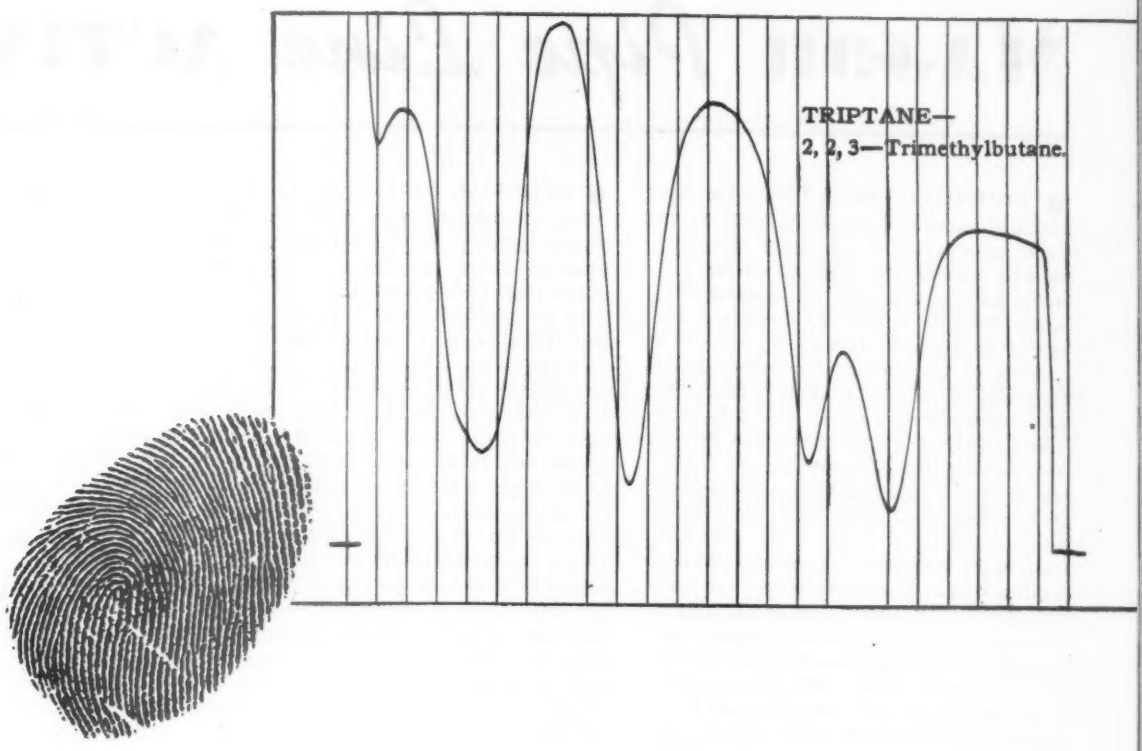
Standard Oil Company of New Jersey refined its billionth gallon of high-octane gasoline at its Baton Rouge, Louisiana, refinery recently, M. W. Boyer, vice president and general manager announced. The Baton Rouge refinery is the second in the nation to reach the billion mark, Boyer said. The Baton Rouge unit has, in addition to 100-octane gasoline, manufactured the components of high-octane to be shipped for blending purposes at other refineries, which, totaled with the finished product, set its production total well over the billion and a quarter mark.

● **TO USE SOUR CRUDE.** Said to be one-third larger than any other plant of its kind in the world, the United Carbon Company of Maryland and Defense Plant Corporation's carbon black plant, Ector County, Texas, will operate on the sour natural gas there. Capacity will be 56,000,000 lb. of carbon black annually and 100,000,000 cu. ft. of gas a day. Serving the double purpose of accelerating production of carbon black and utilizing sour natural gas now being flared or blown into the air in the West Texas fields, the unit is expected to increase greatly the revenue to oil producers who in the past found no use for this gas. In addition to this plant, carbon black plants are being built at Eunice, New Mexico, southeastern Lea County, at a cost of $3,000,000, and at Seagraves in Gaines County, West Texas, at a cost of $2,225,000.

● **TEST PLANT. A small butadiene plant in the chemical engineering building, University of Wisconsin, sponsored by the Rubber Reserve Company, is expected to yield information that will improve the design and operation of synthetic rubber plants throughout the United States. The test plant is being conducted by Professor Kenneth W. Watson of the chemical engineering department. The most important problem now facing American rubber producers, Watson says, is the conservation of butane, the raw material from which both butadiene and an important constituent of aviation gasoline are obtained. Both materials are scheduled for increased production in 1946 and it is imperative that industry learn to use the available butane efficiently.**

● **IMPROVE PLANT.** General Petroleum Corporation has announced that work has been started to expand its refinery at Torrance, California. A $3,000,000 building permit covering the erection of facilities has been filed by the company. Towers reaching 196 ft. above the ground are included in this building project, symbolic of new advancements in science. The new structure will provide General Petroleum with an additional refining process, identified as "delayed recycle coking." The additional facilities will have a capacity of from 13,000 to 15,000 bbl. of components daily and will make the Torrance plant of General Petroleum one of the most efficient and complete in the petroleum industry. Construction work is being done by the M. W. Kellogg Company, which will employ 700 to 800 men.

Fundamentally, the new unit is General Petroleum's answer to the predicted decline in crude oil production in the post-war era. Through the delayed recycle coking method, the heavy, tarry crude residues left over under current refining methods and which have not been refinable, may now be processed until nothing is left but coke, it is stated. Although it means more gallons of gasoline for the war itself, the coking plant will assure a greater volume of postwar products for the consumer, ranging from the highest octane aviation gasoline to diesel and fuel oils and will make possible a controlled production of the highest quality of these products, officials point out.



FINGER PRINT OF A HYDROCARBON

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The UOP infra-red spectrometer "finger prints" hydrocarbons—a valuable aid to our technologists in analyzing hydrocarbon mixtures.

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MAJOR *Pipe Line* ACTIVITIES

● **PROPOSED CHINA LINE.** The National Resources Commission of the Chinese government is planning construction of a 1000-mile pipe line from Yumen, Kansu province, to Kwangyuen, some 500 miles north of Chungking. Inspired by General Joseph W. Stilwell's success in completing the artery from Calcutta to Kunming, more than 1800 miles, the line will be an outlet for the Yumen field. Oil was discovered in the Yumen area several years ago and during the last 3 years has increased to such proportions that refineries have been built in the area. Most of the fuel has been used for trucks, because refining facilities have been inadequate for production of high-octane aviation gasoline. More refineries and pumping equipment is needed to develop properly the extensive oil lands. The crude oil brought from that region to Kwangyeun and then shipped in flat-bottom boats down the river to Chungking is used in trucks with diesel engines. The move to build a pipe line is intended to increase deliveries of the crude oil to the vital war areas. Oil reserves in China have been found to be extensive, reaching from Sinkiang province along the Tien mountains to Kansu and then stretching to the Yellow River basin between Shensi and Shansi. Engineers believe that there is oil to be found deeper in the earth than the Chinese have so far drilled. Their deepest penetration to date is 600 meters at which level the oil reservoir is 26 meters thick. The proposed line would be an important contribution to the war against Japan by reducing shipping requirements.

● **EXTEND PIPE LINE ACT.** *House concurrence in a Senate amendment to extend the emergency pipe line construction act has been passed. The act, made originally to expedite the construction of pipe lines, would have expired June 30, 1945, without the extension. The Senate amendment limited the additional period to one year. The House had voted a two-year extension.*

● **COURT HALTS WORK.** An order halting work on the extension of pipe line facilities of the Memphis Natural Gas Company between Monroe, Louisiana, and Memphis, Tennessee, has been issued by the Fifth Circuit Court of Appeals. The order, sought by the Louisiana Public Service Commission and the State Department of Conservation, would be in effect until disposition of the long-litigated case by the United States Supreme Court. The Memphis Natural Gas Company proposes to double its transmission lines from the Monroe fields to Memphis and west Tennessee consumers and to install additional facilities between Monroe and Lisbon.

● **DISPOSAL OF LINES.** Opinion is being increasingly voiced among oil industry leaders that the satisfactory disposition of the two big wartime emergency pipe line systems from the Southwest to the East Coast is an impossible one. Troubles and involvements are appearing at every turn on the subject of suitable postwar handling of the Big Inch and Little Big Inch lines. Suggestions for handling the question have run all the way from selling them at auction to the highest bidder, to using them for the transmission of natural gas. Currently, according to workers who are investigating the problem prior to the starting of the O'Mahoney committee oil industry investigation, sentiment is growing that they actually ought to be removed from the realm of private economies and held as a national defense facility, insurance against repetition of the shortage that called them into use. Advocates of this plan believe they should be filled with some protective, non-corrosive type of crude oil and refined products respectively, and allowed to lie unused.

● **DENY GAS TO MEXICO.** In a two-to-three decision the Federal Power Commission has refused to authorize the piping of natural gas into Mexico from the United States. Holding that such action would be inconsistent with public interest, the commission dismissed an application by the Reynosa Pipe Line Company, a Texas corporation, for permission to transport 60,000,000 cu. ft. of natural gas daily into Mexico. The majority opinion held that within the group constituting the ownership of Gas Industrial de Monterrey, preference is being given to civilian production over apparently essential war production. It held further that fuel oil is available at a reasonable distance from Monterrey. In an independent dissenting opinion, one commissioner said that he failed to find evidence that granting of the certificate would not be consistent with the public interest.

● **TO PURCHASE FACILITIES.** FPC has authorized Cities Service Gas Company, Oklahoma City, Oklahoma, to acquire from its affiliate, Cities Service Transportation and Chemical Company, and to operate the 231-mile Hugoton 26-in. natural gas pipe line. The order states that the company's ownership of the facilities will improve its financial condition and result in operating economies and a simplification of operations. The acquisition of the facilities, now owned by the Transportation company and operated by Cities Service Gas Company under a 28-year lease, will be as follows: Cities Service Gas Company will purchase from Empire Gas and Fuel Company, its parent, for $3,000,000 cash the Transportation company's outstanding capital stock; will liquidate the Transportation company, and will redeem the company's debt to Empire in the amount of $7,200,000.

The facilities to be acquired include the 26-in. line extending east from a point near Guymon, Oklahoma, in the Hugoton gas field, Texas County, to Cities Service Gas Company's Blackwell compressor station in Kay County, a 15,000-hp. compressor station and dehydration plant at the west terminus of the line, and appurtenances.

● **PROPOSE LINE TO CALIFORNIA.** *The Pacific War Emergency Pipe Line, Inc., has made application for permission to construct a line from West Texas to Los Angeles, California. Proponents of the proposed line were denied a similar permit in 1944 and since then have conferred with PAW. At the outset it was agreed that the hearing would concern itself solely with the need for the line as a war measure and the availability of crude oil to supply the line.*

● **WORK PROGRESSING.** Work is being pushed on preliminary stages of the enlargement of Texas-Empire Pipe Line Company's line from the Southwest to Chicago. The principal part of the enlargement will be the laying of 184 miles of 12-in. loops between Sheldon, Missouri, and Heyworth, Illinois. Considerable right-of-way has been purchased, and permits for crossing highways in Missouri counties obtained. Shipments of pipe from mills are expected to begin about the last of June. Additional pumping equipment is nearly completed at Alluwe, Oklahoma. Work necessary in restoring to service the stations at Sand Springs, Oklahoma, and Scammon, Kansas, is well advanced. The other large current pipe line project in the central states is that of Interstate Oil Pipe Line Company including the laying of 120 miles of 8, 10, and 12-in. crude lines from the Mississippi fields to Baton Rouge, Louisiana.

● **PLANS BIG ARTERY.** Utah Oil Refining Company, Salt Lake City, Utah, registered with the Securities and Exchange Commission 198,828 shares of $5 par value common stock recently as an initial step in financing the construction of a $4,500,000 pipe line. The company proposes to build a 10-in. crude oil pipe line from Rangely oil field, Rio Blanco County, Colorado, to the Wamsutter station, Wyoming, on the main line of the pipe line from Hunton Junction, Wyoming, to Salt Lake City. The amount not needed for construction purposes will be used for general corporate purposes.

THE Petroleum Engineer

JUNE, 1945

DEVELOPMENT ECONOMICS OF CARTHAGE FIELD

By K. MARSHALL FAGIN, *Field Editor*

Except for a few roadside well signs a stranger traveling through the Carthage gas field would not suspect that 60 gas wells are hidden among the pines of Panola County, Texas, over a presently proved area of about 200,000 acres. The completed wells are not marked by derricks or flares. The 23 drilling rigs are so scattered that only a few are visible from any one place.

Approximately $6,000,000 has been invested in the drilling and completing of these wells. About $1,000,000 is being spent each month on 10 new wells. At this rate the present proved area will be developed in about two years with a total of 300 wells. These together with lease equipment will represent a total investment of about $30,000,000 at present prices; but it should be emphasized that the proved area is not defined, and the investment required for full development may be considerably greater.

TABLE 1

A detailed estimate of the cost of drilling a well in the Carthage field, Panola County, Texas.

Item	Quantity	Total cost
6500 ft. of hole	6500 ft.	$39,000.00
10¾-in. O.D. casing (f.o.b. Shreveport)	1500 ft.	2,871.45
7-in. O.D. casing	6500 ft.	8,255.00
2⅞-in. O.D. tubing	6500 ft.	2,405.00
Trucking expense		1,875.00
Cementing services		1,095.00
Electric logging services		750.00
Gun perforating services		2,500.00
Acid and service		3,000.00
Cement		2,500.00
Christmas tree		2,200.00
Clear location and build road		5,500.00
Mud and mud conditioner		5,000.00
Coring, testing, and waiting time		2,000.00
Casing shoes, floats, centralizers, etc.		250.00
Supervisory salaries		500.00
Damages		100.00
Fuel		2,500.00
Company labor		300.00
Extra labor		150.00
Packer		350.00
Drill stem test		500.00
Welding cost		100.00
		$83,701.45
Contingencies and overhead		4,185.07
Total		$87,886.52

● **Many dual completions.** Half of the 60 wells in the field on May 1, 1945, had been dually completed in the Hill sand, in the Upper Pettit lime, or in the lower Pettit lime formations. Only one well was producing from the Travis Peak formation. Thus, the 60 wells provide 90 outlets from the gas-bearing formations, but one or more of the producing zones remained cased-off in many wells. More of the new wells are being dually completed, and it is possible that 300 wells may provide about 450 outlets from the four proved formations. Seldom, however, are all four formations productive in any one well.

The estimated cost of developing the Carthage field would amount to more than ½ cent per 1000 cu. ft. of ultimate gas production, assuming an initial reserve of 5 trillion cu. ft. and exclusive of the development cost for extraction of condensate that accompanies the gas.

Estimates of the total ultimate quantity of condensate to be recovered range from 40 to 100 million bbl., depending on the efficiency of extraction. The estimated cost of developing the field would range from 30 cents to 75 cents per bbl. of condensate without assigning any of the total cost to the gas reserves developed.

At the current price of $1.50 per bbl. for condensate at the well, the cost of development and probably the cost of production will be covered by the income from the sale of the condensate alone. This would leave the value of the gas sold from the wells to provide dividends on the investment.

● **Potential increasing.** The current drilling activity is due to extensions of the proved gas area and lease provisions requiring protection against offset drainage. This is adding producing capacity greatly in excess of present pipe line capacity transportation facilities.

Almost 1 billion cu. ft. daily gas potential is being added each month to the present 5 billion cu. ft. daily potential of the field. Only 2.8 billion cu. ft. of this potential appears on the May schedule because only 32 of the completed wells were connected to the two pipe lines or to field fuel lines. The other wells are shut in.

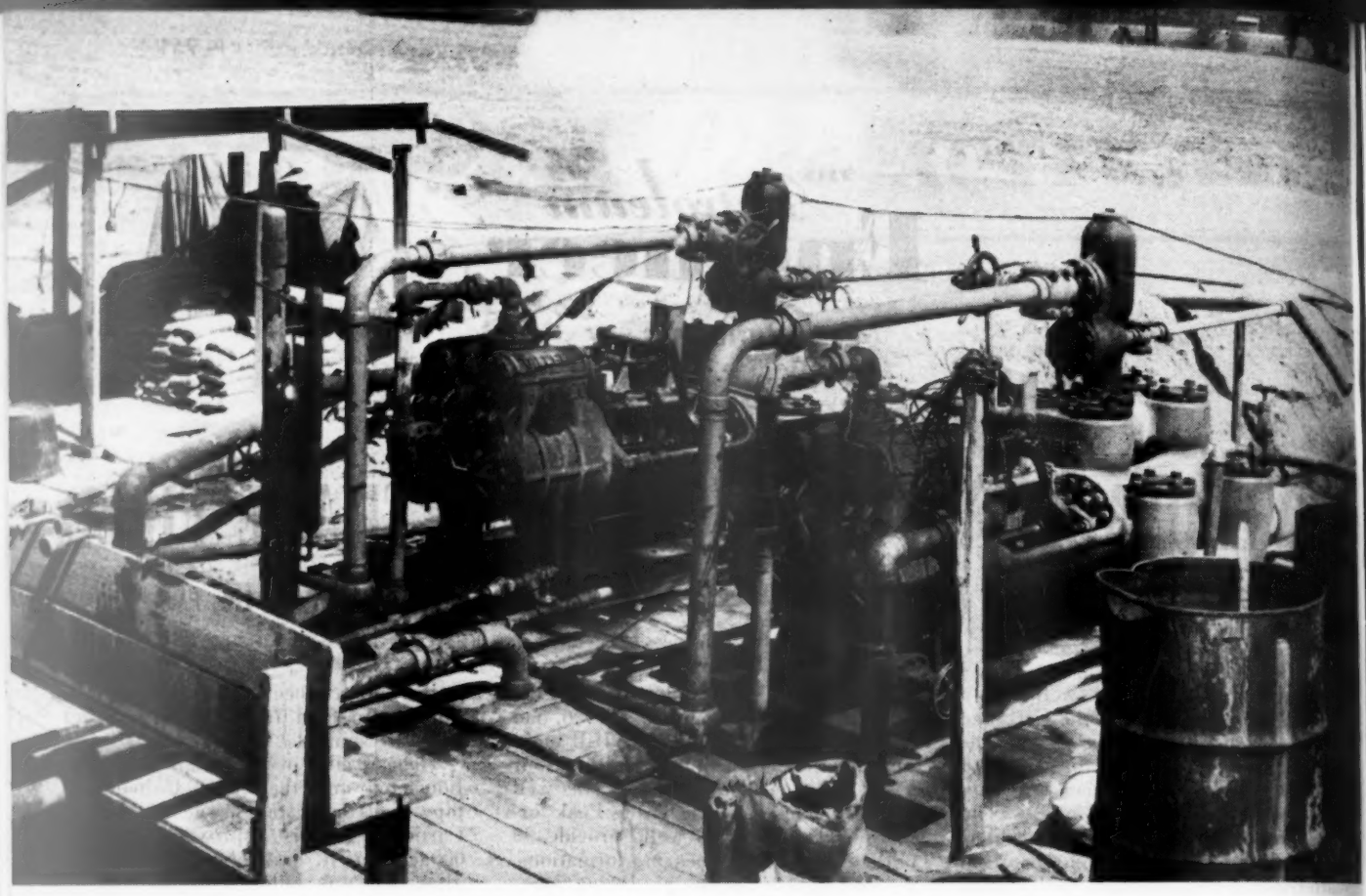
The capacity of the 12-in. Arkansas-Louisiana and the 22-in. United Gas pipe lines now taking gas from the Carthage field is approximately 130,000,000 cu. ft. daily, but the field gas allowable was only 97,000,000 cu. ft. daily during May, 1945. This reflects the lower demand during the warmer months. The allowable for April was 130,000,000 cu. ft. daily, the present maximum outlet capacity. The operators, therefore, face the prospect of diminishing per well allowables and longer payouts until new outlets materialize.

This condition may be alleviated for brief periods during the next two years by the completion of the proposed 24-in. United Gas line to Monroe, Louisiana, and the 14-in. Southern Natural Gas line to Logansport. But these will only increase the field outlet to 300,000,000 cu. ft. per day. Other markets or recycling will be necessary, therefore, to permit a reasonably early pay out of the capital to be invested in the field.

● **Many wells not connected.** The average daily allowable for the 32 connected wells shown on the May, 1945, schedule is 3,000,000 cu. ft. each. This represents 3.4 per cent of their open flow potential. If all the 60 completed wells had shared in the allowable, each would have been allotted about 1,500,000 cu. ft. per day, or about 1.6 per cent of the potential.

Fourteen of the 32 wells on the schedule were dually completed, making a total of 46 formation outlets. The daily allowable per formation outlet was a little over 2,000,000 cu. ft. per day. Had all 90 completed formation outlets shared in the allowable, each would have been allotted slightly more than 1,000,000 cu. ft. per day.

Assuming that an average of 3,000,000 cu. ft. per day per well should prove to be both an efficient and economically sound rate of withdrawal, the field as presently proved will require an outlet of 900,000,000 cu. ft. per day when 300



Checking equipment and conditioning mud prior to drilling plug on a new Carthage well.

wells have been completed, or three times the outlet reportedly planned. Production of 900,000,000 cu. ft. per day would amount to almost 330 billion cu. ft. per year. This volume would probably exceed market demand. Cycling, therefore, will not only increase the efficiency of extraction and ultimate recovery, but also holds promise of providing a way to maintain sufficient revenue from the sale of condensate to prevent the wells from becoming marginal investments.

● **Wells in prospect.** A five-fold increase in the present number of wells is in prospect during the next two years. More than 20 drilling rigs are now completing about 10 wells each month. Perhaps one-half of the 240 prospective wells will be dually completed. This would add 360 producing outlets to the 90 already opened by the 60 wells completed to date.

These estimates are based on the assumption that wells will be drilled on units having an average size of 667 acres in the presently proved 200,000 acre area. Wells may be drilled on 640 acre units, but some of the units may include all the 10 per cent acreage tolerance allowed under the new spacing rules. The 704 acre units thus created will tend to raise the average unit size above 640 acres. This estimate of 300 wells in the field is believed conservative considering the indefinite nature of the present limits.

● **Cost of drilling.** From an operator's viewpoint, the cost of drilling and completing gas wells in Carthage represents a major investment of practically $100,000. All savings that can be made without impairing the physical soundness of the installation or reducing the performance of the well should be welcome. A well must be equipped with casing that with a sufficient margin of safety will withstand pressures greater than 3000 lb. It must also be perforated and acidized to obtain a maximum connection with the gas reservoir. This is especially important for one-third of the allowable is based on potential.

Analysis of Table 1 shows that the drilling contractor receives $39,000 for 6500 ft, of hole, or $6 per ft. This may seem high compared to footage costs of $2 to $3 in the East Texas field for 3500 ft. wells, but the drilling is more difficult. Fifteen to 20 rock bits are generally used from the surface plug to the total depth. From 3000 to 4000 lb. weight on the bits are used to 4800 ft., and the mud pump pressure is held around 900 lb. Crooked holes with the attendant troubles of keyseating, sticking drill pipe, and prolonged fishing jobs have occurred in some instances; but careful attention to bit weight, mud conditioning, and experience in the drillability of the formations has reduced the risk of having these troubles.

The next greatest expense in the drilling operation is $5500 for clearing location and building roads. Most of the wells require ½ mile or more of road. Much of it may be plank road through second growth pine woods with one or more creek crossings to be made passable. This item may amount to as much as $15,000 or more for some of the relatively inaccessible or swampy locations.

● **Drilling mud cost.** The cost of drilling mud weighting and conditioning material is estimated at $5000 for an average well. It is necessary to use 11.5 to 12.0 lb. mud below 5000 ft. due to the high formation pressures encountered. Careful attention to the mud condition and treatment may result in substantial savings in this expenditure, but so far this much needs to be set aside for a safe and satisfactory well completion.

Cement, cementing services, electric log surveys, gun perforating, acidizing services, and drill stem testing cost $10,345. There seems little chance of reducing this expense except by sacrificing important information or weakening the well.

● **Well equipment costs.** Casing, tubing, christmas tree, rig waiting time, fuel gas, lease damages, trucking service, welding charges, labor, supervision, and miscellaneous materials represent a total cost of $23,856. Table 1 shows the amount allotted for each item on a representative well. Some of these charges will vary with an operator's accounting system or buying power, but relatively little can be saved on these items as a whole by most operators. In fact, more money may be necessary on many wells.

● **Total drilling cost.** The cost of drilling and completing a well is estimated at $83,701 plus $4185 for contingencies making a total of $87,886. The possible savings at the present time are limited by rising material costs and possible difficulties in dual completion, setting the

casing, and other operations that may increase rather than decrease the total cost. Approximately 60 days are required to drill and dually complete the wells.

● **Cost of lease equipment.** Analysis of Table 2 will reveal that little, if any, savings can be made on the estimated cost of $6,964.80 for a heater, separator, and lease storage. The choice and cost of these items will vary considerably from operator to operator. Some operators utilize used equipment, and others spend as much as $10,000 or more on lease installations.

● **Cost of development.** Addition of the estimated drilling cost of $87,886 to the estimated lease equipment cost of $6,964.80 makes a total cost of $94,850.80, but this does not include the lease cost. Assuming this to be a little less than $10 per acre, the total cost of development is $100,000.

● **Geology and reservoir data.** The accumulation of gas in the lower Glenrose formations underlying the area is due partly to the existence of a large domal nose on the southwest flank of the Sabine uplift, and partly to an up-dip pinch-out of permeable porosity in the gas-bearing formations toward the shallower Bethany gas field to the Northeast. The relation of Carthage to other fields in the area may be seen in Fig. 1.

The Hill sand has been proved productive from about 20,000 acres in the northeast section of the field. It is found at a depth of about 5000 ft. and ranges from 5 to 20 ft. in effective thickness with an average of about 10 ft. Producing wells completed in this formation have from 10,000,000 to 140,000,000 cu. ft. back pressure potentials. The original reservoir pressure has been estimated at 2600 lb. The reservoir temperature is reported to be 184°F. The 9 Hill wells shown on the May, 1945, schedule had an average daily potential of 88,000,000 cu. ft. each and an average daily allowable of 3.548 million cu. ft. This formation is not considered an important reservoir.

● **Upper Pettit lime.** The Upper Pettit gas-bearing oolitic lime covers about 200,000 acres and is the chief producing formation. Except in two or three places, its areal extent is not defined. It ranges in depth from 5600 to 6000 ft. with a producing closure of more than 400 ft. The effective thickness of the Upper Pettit varies from 5 to 40 ft. with an average of about 16 ft. Producing wells completed in the Upper Pettit zone have back-pressure potentials ranging from 10,000,000 to 155,000,000 cu. ft. The initial reservoir pressure has been estimated at 3000 lb. The reservoir temperature is reported to be 200°F. The 20 Upper Pettit wells shown on the May, 1945, schedule had an average daily potential of 58 million cu. ft. each and an average daily allowable of 1,603,000 cu. ft.

The Lower Pettit gas-bearing oolitic lime covers about 200,000 acres and is the second most important producing formation. Its extent is also not defined except in a few parts of the field. It is found from 40 to 200 ft. below the Upper Pettit at depths from 5700 to 6100 ft. The effective thickness of the Lower

Pettit varies from 5 to 30 ft. with an average of about 14 ft. Producing wells completed in this formation have back-pressure potentials ranging from 5 to 165 million cu. ft. The estimated initial reservoir pressure is 3100 lb. and the reported reservoir temperature 205°F. The 16 Lower Pettit wells shown on the May schedule had an average daily potential of 55 million cu. ft. each and an average daily allowable of 1,923,000 cu. ft.

● **Travis peak reservoir.** The Travis Peak sandstone appears at this time to be the least important gas-bearing formation largely because only one well has been finally completed in it. But most of the wells drilled thus far have set pipe into this zone indicating the possibility of recompletion at a later date in those parts of the field where small quantities of high pressure gas may be obtained. The one well has a back-pressure potential of 11,000,000 cu. ft. and a daily allowable of 2,420,000 cu. ft.

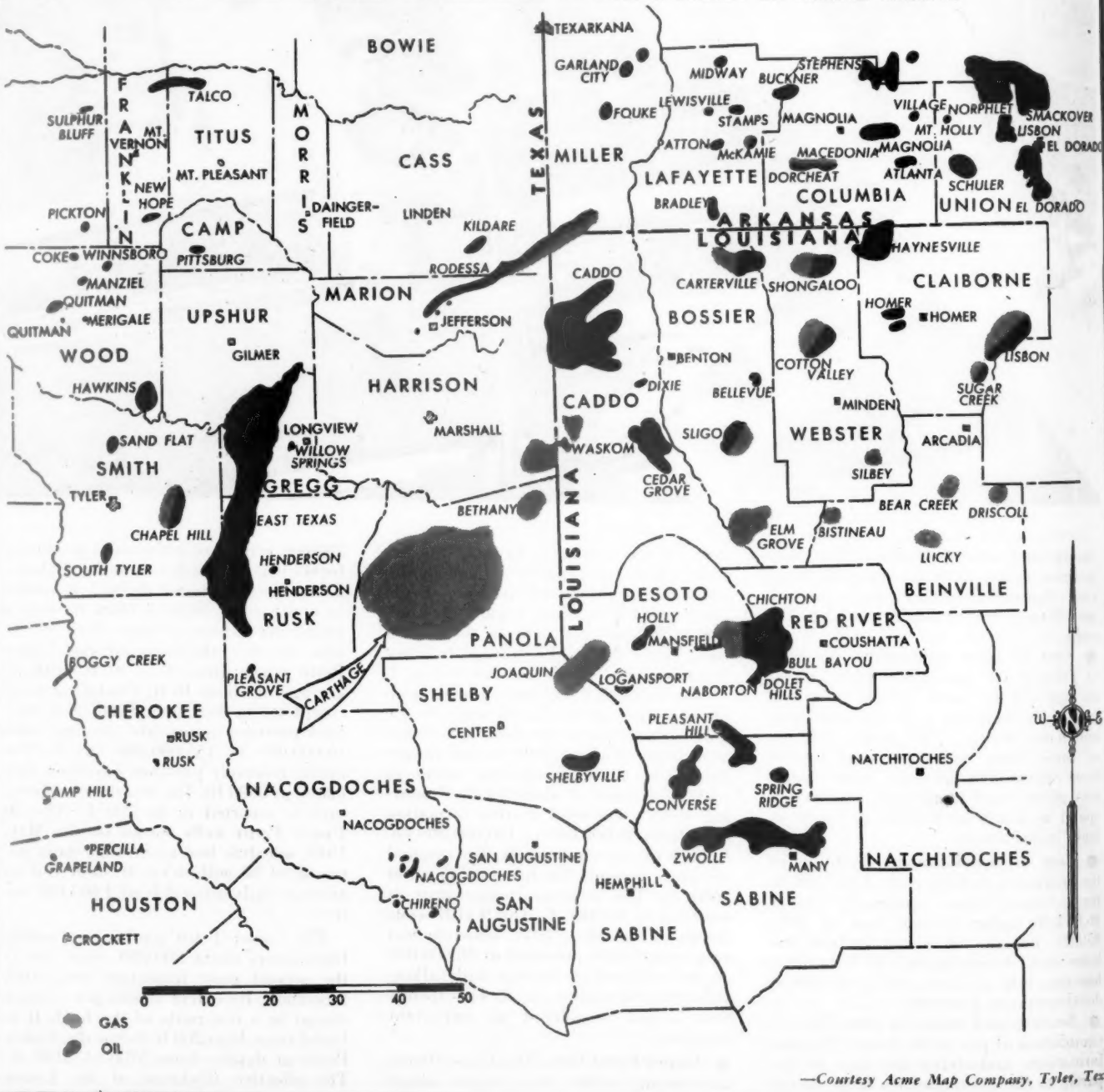
● **Core analyses.** Athough many cores have been obtained only a few analyses have been run. The results cannot, therefore, be considered true averages for the reservoirs, but are presented here as examples. Table 3 shows the porosity and permeability measurements obtained from analysis of cores from the Upper and Lower Pettit oolitic lime zones in the southwestern part of the field. The average porosity of these cores probably represents the highest to be found in these reservoirs, and should not be construed as typical.

● **Permeability irregular.** Although some of these cores had over 20 per cent porosity, the extremely low permeability should be noted especially in the Lower Pettit zone. Likewise, the extreme range of permeability should be noted, especially the large differences between horizontal and vertical permeability with a marked lack of correlation between the two measurements.

● **Average porosity low.** Estimates of average porosity based on several core analyses not shown here, but reported to be fair approximations of the void space available for the storage of gas in the two principal reservoirs are as follows: Upper Pettit 15 per cent, and Lower Pettit 14 per cent porosity.

● **Wildcats preceded discovery.** As may be seen on the development map, Fig. 2, a considerable number of shallow wells have been drilled in the proved area. Most of these wildcats were seek-

FIG. 1. RELATIONSHIP OF CARTHAGE TO OTHER FIELDS ON SABINE UPLIFT.



—Courtesy Acme Map Company, Tyler, Texas

FIG. 2. CARTHAGE FIELD DEVELOPMENT MAP.

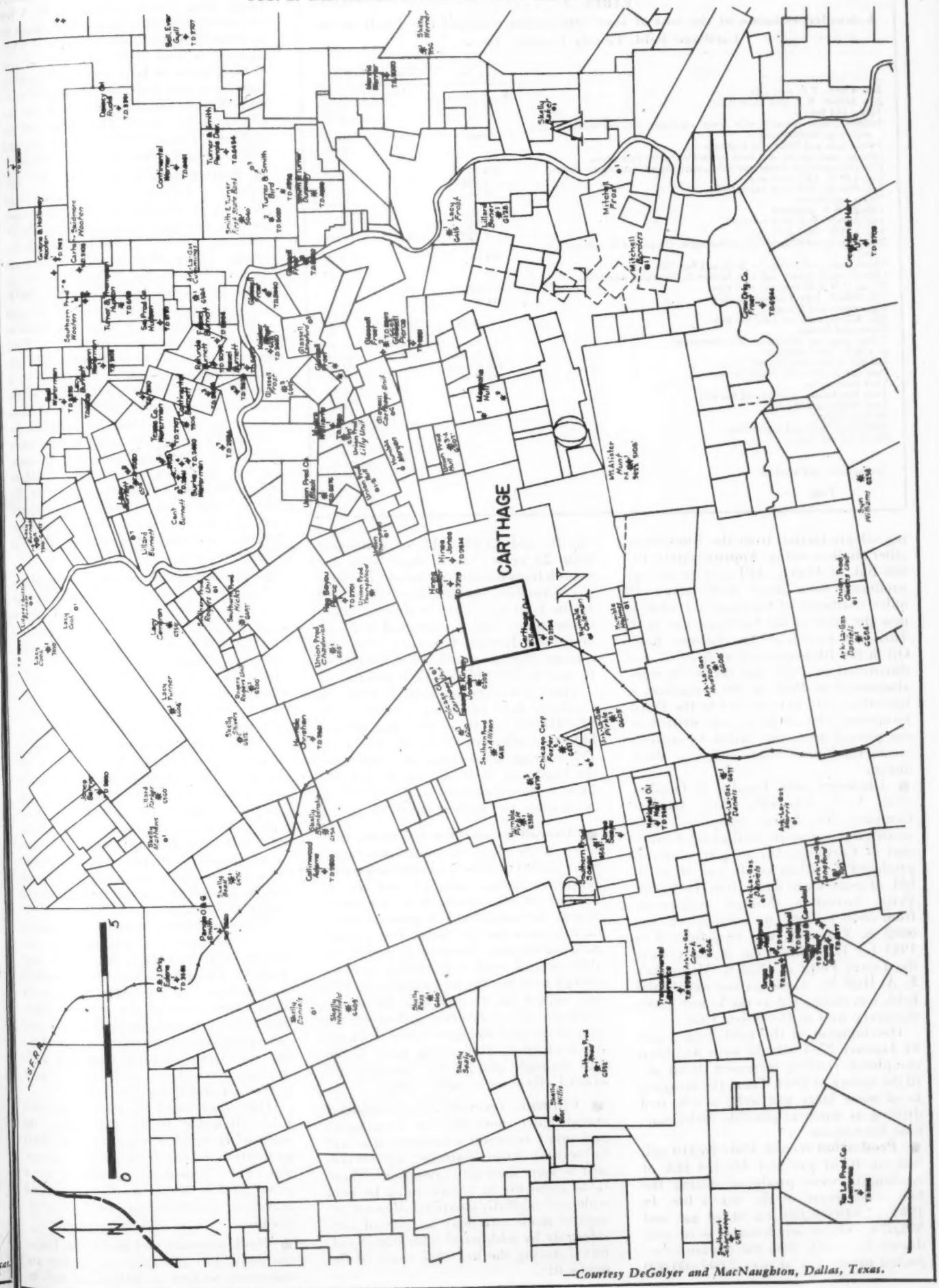


TABLE 2

A detailed estimate of the cost of lease equipment required for a well in the Carthage field, Panola County, Texas.

Item	Unit cost	Quantity	Total cost
2-in. 4.60-lb. P.E. steel pipe	$ 0.254/ft.	225 ft.	$ 57.15
2-in. 3000-lb. W.P. plug valve S.E.	62.38	1	62.38
Valves and fittings			50.00
Indirect heater, complete with temp. controller, fuel gas regulator, and angle type thermometer	827.00	1	827.00
Valves, pipe and fittings for fuel lines			20.00
Cement, sand, gravel, and form lumber for heater foundation			10.00
2-in. pilot operated diaphragm valve, complete with automatic control	274.65	1	274.65
2-in. 4.60-lb. T&C steel pipe	0.254/ft.	25 ft.	6.35
2-in. 3000-lb. W.P. plug valves, S.E.	62.38	3	187.14
Valves and fittings			50.00
1500-lb. W.P. separator	2,370.00	1	2,370.00
2-in. 3000-lb. W.P. plug valve S.E.	62.38	2	124.76
2-in. 3.75-lb. T&C steel pipe	0.22/ft.	50 ft.	11.00
2-in. pilot operated diaphragm motor valve, complete with automatic control	274.65	1	274.65
Valves, pipe, and fittings for drain and flare line			30.00
Cement, sand, gravel, and form lumber for separator foundation			10.00
4½-in. O.D. P.E. seamless steel pipe	0.521/ft.	100 ft.	52.10
2-in. 6000-lb. type T adjustable choke	44.80	1	44.80
Pipe, valves and fittings			50.00
2-in. 3.75-lb. standard T&C line pipe	0.22/ft.	600 ft.	132.00
Valves and fittings			20.00
Valves, pipe, and fittings for drip connection			20.00
20 x 36 ft. fence, complete	59.76/unit	1	59.76
210 bbl. welded steel storage tanks	426.00 each	2	852.00
Stair and walkway for 2-tank battery	129.06 each	1	129.06
Tank connections			35.00
Tank foundations, grading and fire-wall			100.00
Tank strapping and tables			25.00
Welding charges			100.00
Installation labor and supervision			300.00
Truck and car expense			350.00
			$6,634.80
Contingencies and overhead			330.00
Total			$6,964.80

ing oil production from the Blossom or other shallow sands. Approximately 16,000 bbl. of 42-deg. API gravity oil was produced from three wells about 10 miles northeast of Carthage on what is now the edge of the Carthage gas field. This was known as the Tacoma field. Oil in the Blossom sand at 2070 ft. was discovered in 1933, but the wells were abandoned in 1938. In the meantime, a few other tests were drilled to the Pettit formation. One of these was drilled in the proved area, but failed to uncover commercial production and was abandoned.

● **Discovery well.** Finally, in October 1936 A. C. Glassell's Frost Lumber Company No. 1 was completed as a small gas-condensate well about 6 miles east of Carthage. On a ¼-in. choke it produced 4 million cu. ft. and 50 to 70 bbl. of condensate daily from the Upper Pettit formation through perforation from 5648 to 5663 ft. Total depth was 6002 ft. This well was recompleted in 1943 for 120 million cu. ft. daily from the Lower Pettit at 5838 ft. Magnolia's E. A. Hull No. 1, the second well in the field, was completed as the Lower Pettit discovery well in December 1936.

Development of the field lagged and by January 1943 only 15 wells had been completed. Drilling increased slowly until the spring of 1944. Then, the bringing in of some large gas wells accelerated drilling as much as possible under wartime limitations.

● **Production record.** Only 26,419 million cu. ft. of gas and 440,314 bbl. of condensate were produced during the first seven years of the field's life. In 1944, 21,619,000,000 cu. ft. of gas and 313,079 bbl. of condensate were produced. In March 1945 the operators reported production of over 2,041,000,000 cu. ft. and 31,444 bbl. of condensate from 25 wells. Two of these were dual completions making a total of 27 producing formation outlets. The other wells in the field were shut in due to lack of connections. This represented a decline from the January-February 1945 production that averaged 2,973,000,000 cu. ft. and 42,220 bbl. for each month.

From discovery to April 1, 1945, the Carthage field produced a total of 56,026,000,000 cu. ft. of gas and 869,277 bbl. of condensate from all reservoirs. The average gas-condensate ratio since the beginning is 64,451 cu. ft. per bbl. This is the equivalent of 15.51 bbl. of condensate per million cu. ft. of gas.

● **Overall gas-condensate ratio.** Inasmuch as the gas-condensate ratio ranges from 35,000 to 130,000 depending on the formation being poduced and the efficiency of separation, it is interesting to note the remarkable regularity of the overall ratio for the field. The average ratio for the first 7 years was 60,000, the 1944 overall ratio was 69,053, and the overall ratio for the first quarter of 1945 was 68,930 cu. ft. per bbl. Either the efficiency of separation is increasing this year or more of the lower ratio wells are on production. Processing more of the gas through plants will increase the overall efficiency considerably.

● **Ultimate recovery.** As previously stated, much more data on the porosity and other reservoir characteristics will be needed before estimates of reserves will be more than approximations. These facts about the reservoirs must be field wide and carefully compiled. Reserve estimates made now may be altered considerably by additional information collected during the next few years of the field's life.

Most estimates of ultimate recovery range from 3 to 6 trillion cu. ft. A few estimates are lower and a few range up to 10 trillion cu. ft. An estimate of 5 trillion cu. ft. and 60,000,000 bbl. of condensate seems to be a reasonable approximation at this time for the 200,000 acres and 30 ft. of effective section in the two principal pay zones. This discounts the Hill and Travis Peak pay sections and allows them to serve as safety factors.

● **Factors used in estimate.** The estimate of 5 trillion cu. ft. amounts to an average of 833,000 cu. ft. recoverable gas per acre-foot on the basis of 600,000 effective acre-feet in the field in all reservoirs. Using 14 per cent as the average permeable porosity, 3000 lb. as the average initial reservoir pressure, 200°F. as the reservoir temperature, 15 per cent connate water, and a deviation factor of 1.12 for 0.65 gravity natural gas. Each average acre-foot of sand originally contained approximately 925,000 cu. ft. of gas. Recovery of 833,000 cu. ft. of the estimated original 925,000 cu. ft. amounts to the recovery of about 90 per cent. Assuming the reservoirs lack effective water drives, the terminal reservoir pressure at the time of abandonment would be about 300 lb., and perhaps another 30,000 or 40,000 cu. ft. might be produced per acre-foot, if low pressure gathering systems or compressors are available at that time.

● **Method of allocation.** The total gas allowable for each reservoir is determined each month by the Texas Railroad Commission from nominations submitted by the well operators, gas pipe line companies, or other purchasers taking gas from the wells. The Commission adjusts the allowed production as determined by this method to the actual production from the field as determined by its records.

Two-thirds of the total allowable for a given reservoir is distributed to the wells in the reservoir in proportion to acre-pounds. A glance at the map (Fig. 2) will indicate the difficulties facing operators in attempting to form any regular 640-acre drilling units. Therefore, a tolerance of 10 per cent is allowed. This means that some wells will receive credit in the allocation formula for as many as 704 acres.

The actual acres in a given production unit is multiplied by the rock pressure of the well to obtain the well's acre-pounds. The acre-pounds of all wells in a given reservoir are added to obtain the total. Two-thirds of the month's allowable for a reservoir divided by the total acre-pounds provides the acre-pound factor. This factor multiplied by each well's acre-pounds gives each well's acre-pound allowable for the month.

The other third of each reservoir's total allowable is divided among the wells in the respective reservoir in direct proportion to the back-pressure potential. The "potential" allowable for a given well is added to the acre-pound allowable to obtain the well's total allowable.

● **Rock pressure and potential.** Under this method of allocation two factors are important to give an individual well its

share of the total allowable for the reservoir in which it is completed. First, it should have an average rock pressure. This is the shut-in wellhead pressure. Liquid in the well will tend to reduce this pressure. The rock pressure will usually be higher in a new part of the reservoir unless the well produces water.

The second factor that plays an important role in allowable granted an individual well under the present method of allocation is the back-pressure potential. This is sometimes called the "open flow" potential, but most wells, especially large ones are not opened wide to make this measurement. Instead, the wells are flowed for an hour or two on a small positive choke until the flow appears stabilized.

The well-head temperature and pressure are measured, then the well flowed through a smaller positive choke until stabilized. The pressure and temperature are again recorded. The process is repeated through a still smaller choke. This provides a set of volumes and pressures that can usually be plotted on graph paper as a straight line. This line is extended to the point where the well pressure would register zero, and the calculated open flow potential is read on the volume scale.

● **Conditions affecting potential.** The back-pressure potential of an individual well will be less if liquid is produced with the gas or if the connection with the reservoir is poor. The latter condition is usually guarded against by adequately perforating the casing opposite the gas-bearing strata and by the liberal use of acid in the oolitic lime reservoirs. Corrections are made for the size of the tubing or annulus, but unusual obstructions in the well bore may affect the results considerably.

Circulating and conditioning mud preparatory to perforating casing in a new Carthage well.

TABLE 3

Analysis of cores from the Upper and Lower Pettit oolitic lime pay zones in the Southwestern part of the field.

Depth, ft.	Porosity, per cent	Permeability md.	
		Horiz.	Vert.
Upper Pettit			
5814	15.6	1	1
5815	16.8	60	1
5816	16.8	1250	550
5817	21.1	39	870
5818	24.7	2140	73
5819	25.6	1540	810
5820	25.0	1970	250
5821	24.8	2050	43
5822	20.6	1420	21
5823	22.1	198	1010
5824	18.6	6	94
5825	19.5	54	42
5826	20.2	710	62
5827	22.0	41	59
5828	13.5	2	0
5830	13.7	0	0
Lower Pettit			
6002	15.3	0	0
6003	12.9	0	0
6004	21.9	7	0
6005	26.9	79	22
6006	23.6	3	0
6007	23.9	1580	2130
6008	21.7	1	1
6009	22.1	1360	2
6010	25.4	12	3
6011	25.5	22	16
6012	23.2	3	3
6013	23.3	2	1
6014	25.0	2	2
6015	25.5	12	5
6016	23.2	18	6
6017	20.0	6	1
6018	20.0	3	4
6019	19.1	7	2
6020	10.5	0	0

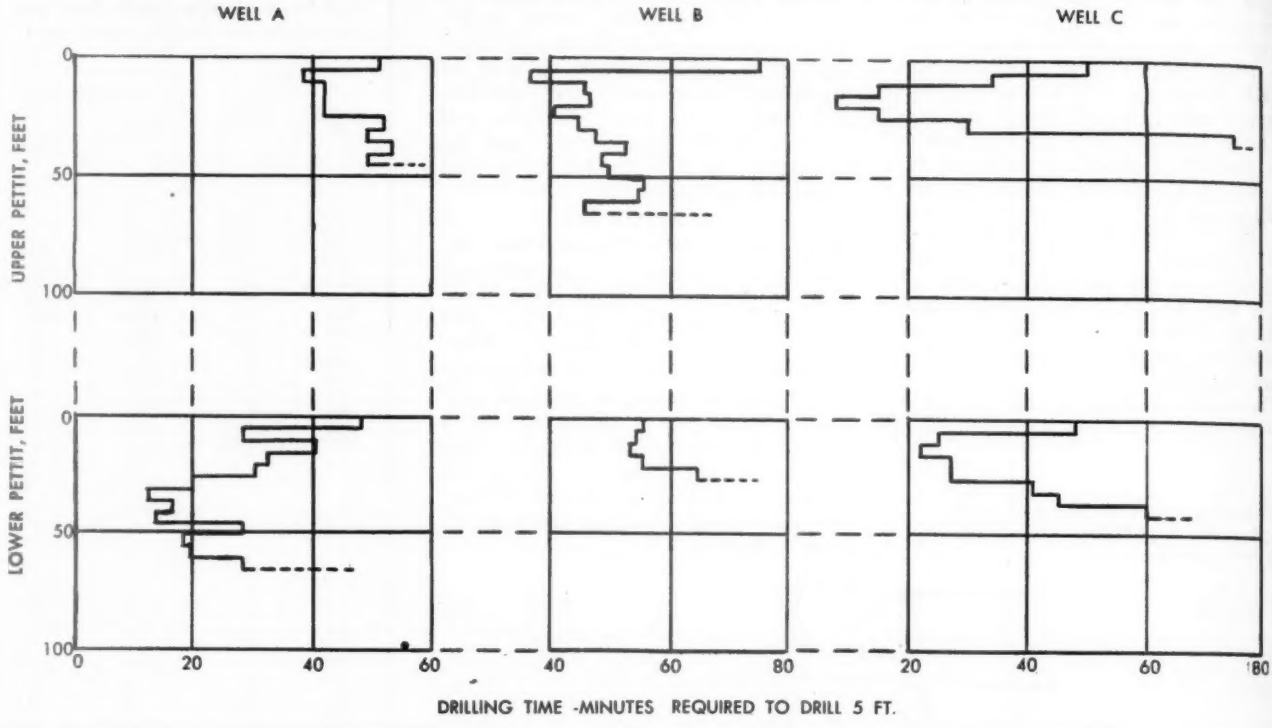
Dually completed wells are treated as two separate wells so far as allocation of allowable is concerned. Each zone outlet receives its own individual allowable. Some of these wells have total daily allowables for May in excess of 6 million cu. ft.

● **Factors governing value.** The old adage, "The more you put into something the more you get out of it" is not necessarily applicable to gas wells in the Carthage field. The operators are investing heavily. Approximately $100,000 is being put into each well, but many as previously stated are shut in for want of a connection. However, the plans for more connections and more plants and pipelines are expected to provide outlets for all the wells.

When the presently proved field is fully developed with 300 wells and all are connected to gathering systems, the present worth of the wells will depend largely on the price received for the production and the average daily allowable.

● **Dually completed wells.** Dual completion wells will generally have twice the value of single zone completions, but so far as this discussion is concerned the wells will be treated as units. The average well would be located on a 666-acre lease unit. It would have an initial reserve of 16,667,000,000 cu. ft. of gas and 200,000 bbl. of condensate. The gross revenue from the sale of these reserves during the life of the well would amount to approximately $800,000. This is based on an anticipated average price of 3 cents per 1000 cu. ft. for gas and

FIG. 3. DRILLING TIME CURVES THROUGH UPPER AND LOWER PETTIT PRODUCING ZONES.



$1.50 per bbl. for condensate. The operator's seven-eighths would be $700,000. The remainder would belong to the royalty owner. It is assumed that if the efficiency of gas-condensate separation is improved by the installation of plants, all would benefit to a greater extent.

The present worth of the wells—of the field, in fact—hinges primarily on the prices obtained for the production and the rate of production. One factor tends to work against the other. If the price is higher the rate of production would probably ease off, for users would seek cheaper fuels. Let us assume, therefore, that price remains constant.

● **Estimated life of field.** At 1,000,000 cu. ft. per day per well, the field would need an outlet for only 300,000,000 cu. ft. per day. The reserves would last about 46 years, and the payout on the average well would exceed 6½ years excluding interest and producing costs.

At 2,000,000 cu. ft. per day per well, the field would need an outlet for 600,000,000 cu. ft. per day. The reserves would last about 23 years, and the average well would be paid out in about 3 1/3 years not counting producing costs and interest on the investment.

At 3,000,000 cu. ft. per day per well, the field would require an outlet for 900,000,000 cu. ft. per day. The reserves would last approximately 16 years, and the average well would be paid out in a little over 2 years.

● **Capacity of field outlets.** The present field outlets are reported to have a capacity of from 100,000,000 to 130,000,000 cu. ft. per day. United Gas Company operates a 22-in. line connecting with its gathering system at Waskom, Texas, and its South Texas lines toward Houston. Arkansas-Louisiana Gas Company operates the only gasoline plant presently completed in the field and takes gas from the field through a 12-in. branch line from the Bethany field.

United Gas has proposed building a 24-in. line from the field to Monroe, Louisiana, to connect with the Tennessee Gas and Transmission's new 24-in. trunk line that extends from South Texas to the Appalachians. The field outlet would be increased about 100,000,000 cu. ft. per day by this connection.

Southern Natural Gas Company has proposed extending its gathering system by the installation of a 14-in. line from Logansport, Texas. This may provide an additional field outlet of 40,000,000 cu. ft. per day. Lone Star Gas Company has under consideration an extension of its gathering system from Athens, Texas. Another company is reported to have filed an application for a line from the field, but data on the proposed capacity is not available.

The Chicago Corporation has prepared the ground for a plant West of Carthage on the Henderson highway. United Gas selected a site immediately south of the town.

● **Recycling and Fisher-Tropsch processes.** The present field outlet capacity of approximately, 130,000,000 cu. ft. daily plus the proposed outlet capacity announced at the time this is written will probably not exceed 300,000,000 cu. ft. This indicates that recycling or a Fischer-Tropsch unit for converting natural gas into gasoline will be needed to keep the well operator's revenue at an interesting profit level. Plans for both of these methods of increasing the ultimate recovery have been under consideration by the operators.

● **Carthage engineering committee.** Owners of leases covering more than 90 per cent of the presently proved area of the field have recently organized the Carthage Field Engineering Committee. The purpose of the committee is to compile factual data on the producing reservoirs for use of the operators and conservation authorities. W. H. Barlow, formerly a petroleum engineer with the Ohio Oil Company, has been selected as the director. An office has been opened in the town of Carthage.

R. O. Garrett of the Arkansas-Louisiana Gas Company at Shreveport, Louisiana, is chairman of the executive committee. Other members of the committee include T. W. Johnson of the Union Producing Company; A. C. Glassell, Shreveport; H. K. Greenleaf of The Chicago Corporation; J. O. Sue of the Humble Oil and Refining Company; F. N. Speller, Tyler, and Colin Rae of Skelly Oil Company.

The formation of this committee to gather, arrange, and record fundamental information on the nature and characteristics of the separate reservoirs that comprise the Carthage field represents an important step toward conservation of this valuable reserve. The facts to be obtained on permeability, porosity, effective thickness, and extent of the reservoirs, together with reservoir pressure and production records, will constitute the foundations on which true and important conservation measures can be built. Now, while the field is relatively new and the gas and condensate reserves are practically the same as they were originally, is the time when the facts can mean the most to everyone concerned. The foresight of all who are responsible for the organization of this committee is commendable. ★★★

FOUR REFINERS CONVERT CRACKING PLANT TO WAR

By **PAUL TRUESDELL** and **W. E. LEMEN**
Universal Oil Products Company

THERE is a 100-octane gasoline plant in the Pennzoil refinery at Oil City, Pennsylvania, that represents extension into the war effort of a joint oil-cracking enterprise that was set up by four neighboring refiners almost 15 years ago. They are The Pennzoil Company, The Quaker State Oil Refining Corporation, The Wolf's Head Oil Refining Company, and The Continental Refining Company.

The four joined together in 1931 to install a 2500-bbl. per day single coil UOP thermal cracking unit for their common use. It was named Dubbs No. 3. It replaced Dubbs Nos. 1 and 2 of 1000-bbl. daily capacity each, which had been installed by Pennzoil alone in 1927.

Dubbs No. 3 was the first joint cracking plant in the history of the oil industry and the arrangement entered into by its owners was unique. They did not form a corporation or a partnership. They were and are keen competitors, yet they have gone along to this day amicably and successfully, their obligations defined and their rights safeguarded by nothing more than a mutual understanding set forth in a simple contract.

The satisfactory working out over the years of this informal agreement has demonstrated the fact that, by joining forces, small refiners, even competitors, can enjoy the benefits of modern facilities that might be too costly for one to finance, and can effect economies together that no one of them could accomplish alone.

It gave the co-owners confidence to venture together into the war production program.

The No. 3 unit was built on Pennzoil land and is operated by that company. Each participating refiner supplies his proportionate share of cracking stock, bears his share of the costs and takes his share of the products. Pennzoil supplies more than half of the charging stock.

Cracking of Pennsylvania oils proved so satisfactory that Pennzoil alone, in 1932, installed a UOP thermal unit for reforming and once-through cracking, which was christened Dubbs No. 4. This is not a part of the common cracking plant.

In 1938, the four-company cracking unit was converted to 2-coil operation by the addition of a light oil heater and its capacity was increased to 4500 bbl. a day. In the following year the associated refiners installed a 200-bbl. a day UOP catalytic polymerization unit to polymerize the olefins in the overhead condensate from the thermal cracking unit stabilizer, thus increasing the overall yield of gasoline from the crude and improving its octane rating.

At about that time, Pennzoil management, foreseeing a great future for catalytic cracking, had begun to explore with Universal Oil Products Company the economic feasibility of a fluid catalytic cracking unit as a means of improving the quality of their gasoline.

The imminent threat of war to the United States brought the matter to a head. In October, 1941, a few weeks before Pearl Harbor, W. S. Zehrung, president of Pennzoil, with the consent and approval of the other refiners, decided that the time had come to install a common catalytic cracking unit.

The primary objective was to put the refinery into the war effort most effectively as a producer of aviation gasoline; the secondary purpose was to assure the companies of the ability to meet any high octane standards that might prevail in the postwar gasoline market.

The four refiners were ready to pay for the catalytic cracking unit with their own money.

From that decision grew the present 100-octane gasoline plant, which goes far beyond the original plans. It comprises the three elements that make up a complete aviation gasoline refinery, namely, a single-stage fluid catalytic cracker of 4500 bbl. daily capacity, a gas concentration unit, and a UOP HF alkylation unit designed to produce 740 bbl. per day of alkylate.

The catalytic cracking unit, with the auxiliaries and alterations to other process units that it necessitated, cost the co-owners more than $2,000,000, and the gas concentration and alkylation units, with auxiliaries, which were financed by the Defense Plant Corporation, cost well over $3,000,000 more. These facilities are operated by Pennzoil under contract with the government.

That small refiners, by joining forces, can enjoy benefits of modern facilities, is demonstrated by joint operation.

These combined facilities are actually turning out today for our fighting flyers and those of our allies, 50 per cent more 100-octane gasoline than they were originally expected to produce.

From the time the decision was taken to convert to war production, direct responsibility for seeing the program through devolved upon D. W. Grant, vice president of The Pennzoil Company. The completion and the outstanding performance of the plant, testify to his achievement.

● **Main Pennzoil refinery.** At the time the joint aviation gasoline plant was projected, Pennzoil was producing from Pennsylvania crude at its No. 1 plant at Rouseville, 3 miles north of Oil City, the following products:

S. R. gasoline—360°F. e.p., 52 octane number, 6 lb. R.v.p.

Kerosine (w.w.)—360-525°F. b.p., 45 API gravity.

Light gas oil-400-700°F. b.p., 40 API gravity.

Wax distillate.

Steam cylinder stock.

The straight-run gasoline was reformed in Dubbs 4, the kerosine was sold or cracked, as conditions required, and most of the gas oil went to the common cracking unit. The wax distillate and cylinder stock were processed in the complete modern lube plant into the celebrated "Pennzoil," a Pennsylvania motor oil. Today, a methyl-ethyl-ketone solvent dewaxing plant is under construction in Plant 1.

In October, 1942, ground was broken for the aviation gasoline plant. It was a combination conversion and new construction job. Universal was the designer and licensor of the processes, and Arthur G. McKee and Company was the engineering contractor. Both companies collaborated with Pennzoil in installing the earlier UOP thermal cracking units and in making all subsequent additions and changes thereto.

The new facilities were placed on two separate pieces of land stretching along Pennsylvania State Highway No. 8, which follows the course of Oil Creek northward out of Oil City. They are known as Plants 2 and 3.

The new catalytic cracker was placed in Plant 2, where Dubbs No. 3, Dubbs No. 4, and the polymerization unit are situated. By an interesting coincidence, the cat cracker was built on the exact site of old Dubbs 1 and 2. Plant 2 is about 2 miles south of No. 1. The Quaker State refinery, known as the "Independent Plant," adjoins it on the south and the plant of the Continental Refining Company bounds it on the north. The Wolf's Head refinery is at Reno, about 6 miles away.

Plant 3, also called the DPC plant, is a third of a mile north of Plant 2 on a 5-acre tract that was purchased by Pennzoil for DPC. It contains the gas concentration unit, the HF alkylation unit, and the necessary utilities, including a new cooling tower, a new boiler plant, and complete facilities for inhibiting, ethyliz-

ing, blending, storing, and shipping aviation gasoline. Everything in Plant 3 was financed and is owned by Defense Plant Corporation.

● **Thermal cracker converted.** Dubbs No. 3 was the starting point in the war conversion program, although in 1942, before the work began, the four refiners had made a contribution to the aviation gasoline supply by converting the polymerization unit from motor polymer to codimer production.

Dubbs No. 3 is the first UOP thermal cracking unit ever to be tied into a catalytic cracking operation. Here is the way it was done.

The fractionator, which had almost reached the retirement stage for high pressure operation, was found to be of suitable size to serve, with minor changes, as the fractionator for the catalytic cracker. So it was moved to the proper location and placed in a service that requires an operating pressure of only 5 lb. A new tower, designed for 90-lb. pressure, was installed on the thermal cracker.

It was evident that under the new scheme, the thermal cracker would lose its old job, because the gas oil and kerosine formerly charged to it would go to the catalytic cracker instead. The only material available for thermal cracking would be catalytic cycle stock, amounting to 1500-2000 bbl. per day, and straight-run gasoline.

It was found that the original 2-cell heavy oil heater of the thermal cracker, a 45,000,000 B.t.u. per hr. furnace, had sufficient capacity to handle all the catalytic cycle stock. Two-coil operation could be carried out by merely separating the coils, using one side for light and one for heavy oil. This was done, giving the unit a capacity of about 2500 bbl. a day and effecting a substantial economy.

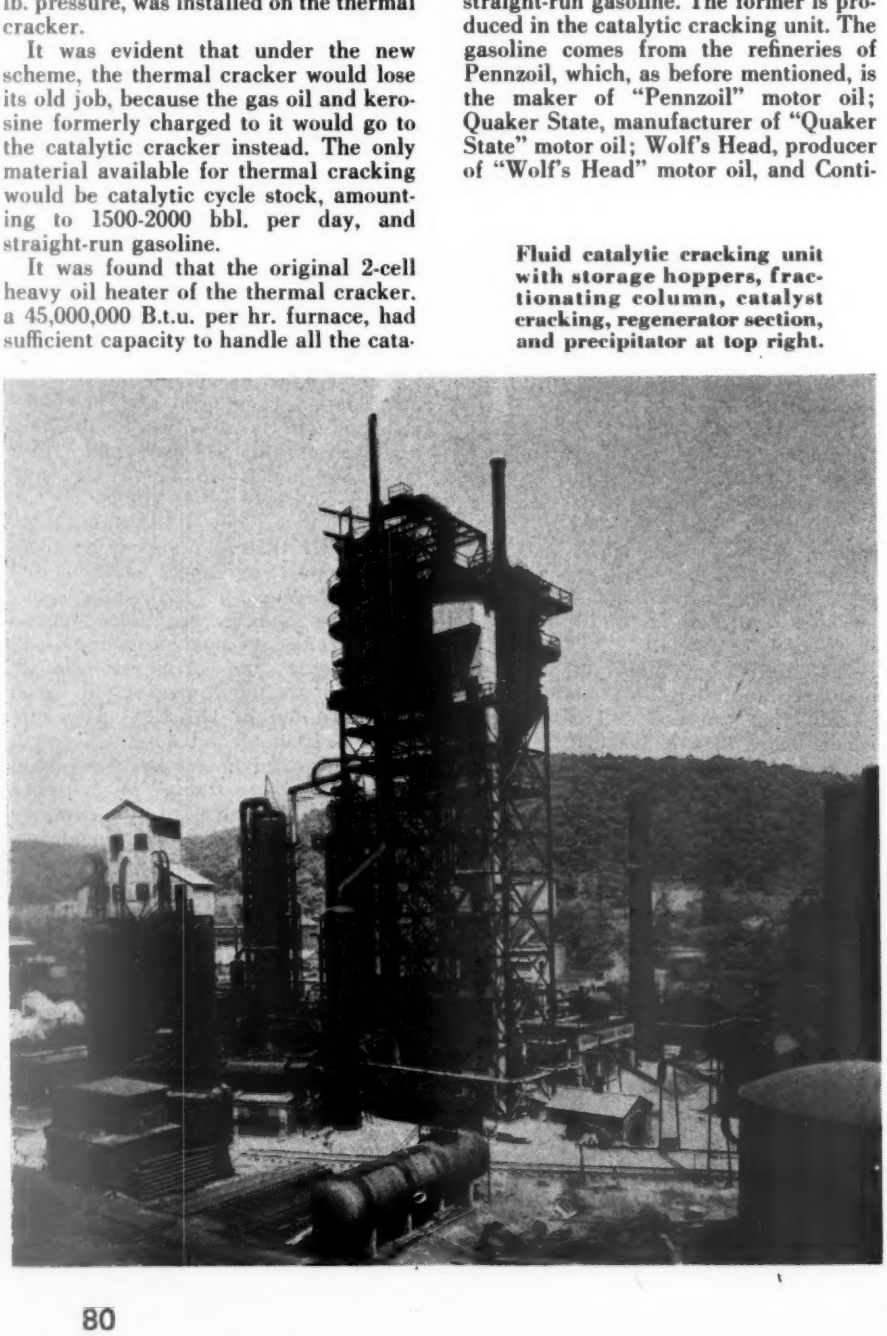
Through this arrangement, the light oil heater, a 30,000,000 B.t.u. per hr. furnace, was released for use, without being moved from its original location, as a heater for the feed to the catalytic cracker.

A UOP center wall updraft reforming heater, of 3500 bbl. daily capacity, was added, so that the reforming of straight-run gasoline and cracking of cycle stock could be done in a single unit, thereby economizing on manpower and operating costs.

The remodeling of Dubbs 3 was carried on in such a manner that its operation was interrupted for only two months.

In its new role today, this thermal unit is cracking about 1600 bbl. per day of cycle stock and 2500 bbl. per day of straight-run gasoline. The former is produced in the catalytic cracking unit. The gasoline comes from the refineries of Pennzoil, which, as before mentioned, is the maker of "Pennzoil" motor oil; Quaker State, manufacturer of "Quaker State" motor oil; Wolf's Head, producer of "Wolf's Head" motor oil, and Continental, manufacturer of "Coreco" motor oil.

Fluid catalytic cracking unit with storage hoppers, fractionating column, catalyst cracking, regenerator section, and precipitator at top right.



The cycle stock is pumped directly from the fractionator of the cat cracker into the thermal cracker fractionator, which operates at a top temperature of 370°F., bottom temperature of 615°F., and 93-lb. pressure. Heavy combined feed from the bottom of the fractionator is charged to the heavy oil side of the heater and light combined feed, as a side cut from the fractionator, is charged to the light oil coil.

Heat is recovered from the fractionating column by circulation of side cut and bottoms through steam-generating heat exchangers, which together produce 18,000 lb. per hr. of 125-lb. steam. This method of heat recovery was installed as the economical way to relieve the load on an old and overtaxed boiler plant.

The heavy oil stream leaves the heater coil at a transfer temperature of 915°F. and goes into the top of the reaction chamber, which operates at 375-lb. pressure. The light oil stream leaves the coil at 945°F. and joins the heavy oil stream at the reaction chamber outlet, ahead of the pressure control valve.

Vapors from the reformer, leaving the heater at transfer temperature of 975-1000°F. and at a pressure of 500 lb., are quenched with light oil to a temperature of 800°F., passing through a pressure control valve and joining the other streams at the primary flash chamber inlet.

Overhead from the primary flash chamber enters the fractionator at a point below the inlet of the cycle stock. Primary flash chamber bottoms go to a secondary flash chamber operating at 30-lb. pressure and 525°F. temperature. Overhead from the secondary flash chamber is used as transfer quench and flash chamber reflux. Bottoms from the secondary flash chamber, black fuel oil of 10-deg. API gravity, represent about 10 per cent of the gasoline-cycle stock charge.

Feed to Dubbs No. 3

Straight run gasoline—360 e.p., 52 octane number.

Catalytic cycle stock—36-37 °API gravity, 400°F. I.B.P. 650° end point.

Products from Dubbs No. 3

	Volume, per cent	Bbl. per day
Motor gasoline fractions, 400°F. end-point, 64-65 octane rating, 5-6 lb. R.v.p.	72-77	2900-3100
Butylenes	5	200
Isobutane	1.5	60
Bottoms	10	410
Gas	9-12	----

Overhead from the fractionator goes to a receiver where liquid and gas are separated. A 2-cycle 200-hp. gas-engine driven Clark compressor compresses the gases from 90 to 225 lb., and delivers them to the deethanizer of the gas concentration system for the recovery of C_3 and heavier hydrocarbons.

Unstabilized gasoline from the receiver goes to a pair of stabilizers operating in parallel as a debutanizer. The overhead condensate is charged to the depropanizer of the gas concentration

system. The bottoms are debutanized motor gasoline fractions.

The butylenes and isobutane recovered make up a part of the charge to alkylation; thus, the thermal unit has a substantial part in the production of aviation gasoline, as well as in converting cycle stock and straight-run into motor gasoline.

Catalytic naphtha from the bottom of the rerun column of the gas concentration system, and motor polymer when available, are blended with the thermally cracked and reformed motor gasoline and its vapor pressure is raised to specifications by the addition of normal butane recovered from the thermal and catalytic BB fractions and separated in the debutanizer of the alkylation unit.

Dubbs No. 4 is now employed by Pennzoil alone as a standby for motor fuel production, being used to crack excess gas oil or kerosine or to reform excess straight-run gasoline.

The catalytic polymerization unit, which was robbed of its normal feed in the new arrangement, was modified so that it could process the gas concentration depropanizer overhead to produce motor polymer. This was accomplished by combining the depropanizer overhead and the normal butane stream from the alkylation unit debutanizer in the poly unit feed drum, providing a liquid feed that can be processed without extensive alterations to the existing equipment. Normal butane thus recovered is combined with the debutanized motor gasoline components along with the polymer.

● **The catalytic cracking unit.** Although the processes that take part in the production of aviation gasoline are interdependent, top honors for usefulness probably should go to the fluid catalytic cracking process because it is the largest producer of the components of 100-octane gasoline.

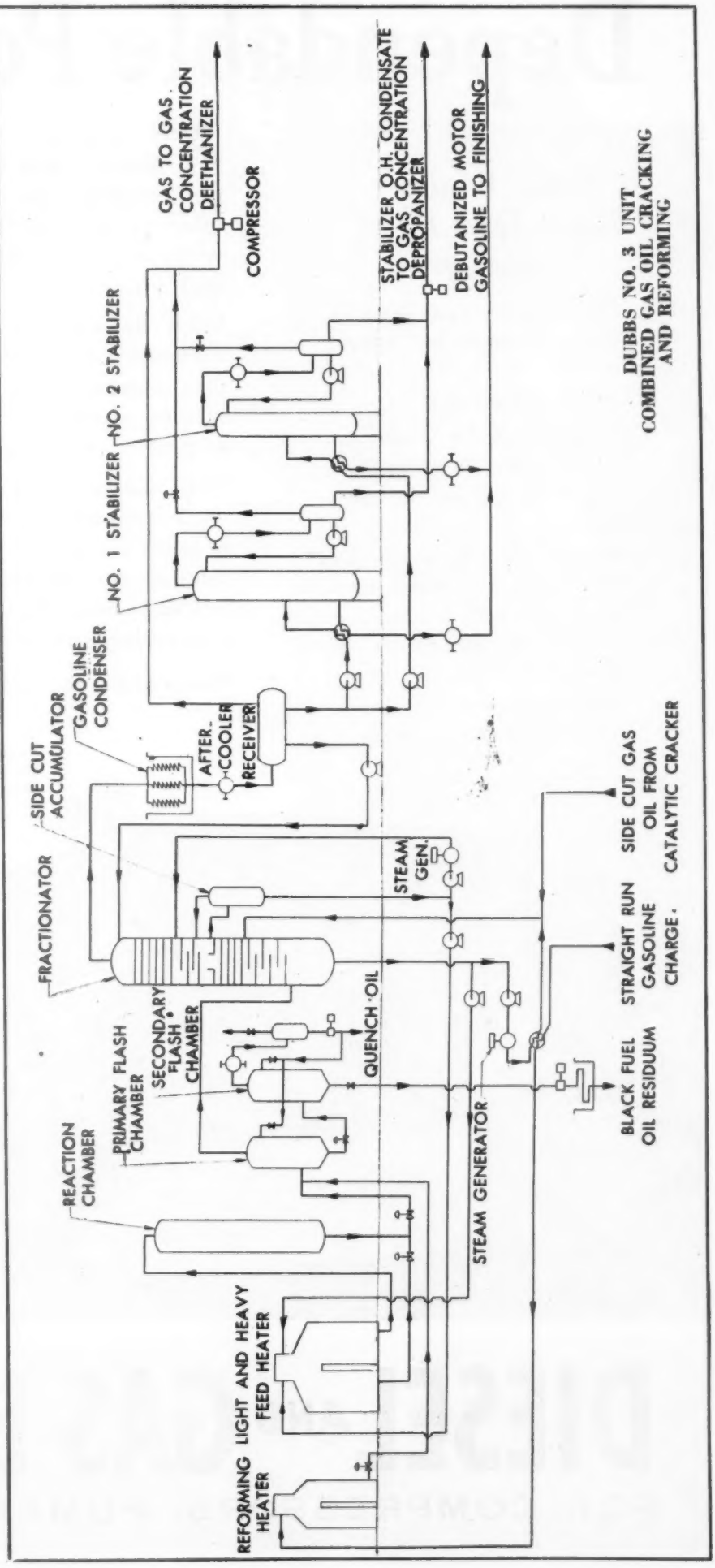
Those components are base stock, alkylate, and isopentane. The catalytic cracker produces all the base stock, most of the isopentane, and the greater part of the isobutane and butylenes that go to make up alkylate. In one method of operation, the cat cracker has produced from a virgin feed of 4300 bbl. a day, these vital products:

	Bbl. per day	Volume, per cent
Depentanized 330° F. end rating, 5-6 lb. R.v.p.	72-77	2900-3100
C_3 fraction	460	10.7
Butylenes	325	7.5
Isobutane	460	10.7

The 4500-bbl. daily design capacity of the catalytic cracker was based on a charge composed of 3900 bbl. of gas oil of 39-40 API gravity and 600 bbl. of kerosine of 45 API gravity. It was expected that the gas oil and kerosine produced in the Pennzoil plant and in those of the co-owners would be sufficient to supply the feed stocks in that ratio and in the quantities needed. Owing to shortage of Pennsylvania crude, that condition has not prevailed. Consequently, it has been necessary to purchase gas oil from other sources.

Under these conditions the catalytic cracking unit has demonstrated its ver-

(Continued on Page 84)



Dependable Power that i

Cooper-Bessemer
Diesels Serve the oil industry:

1. Produce electric power where energy cannot be bought economically.
2. Power drilling rigs.
3. Drive pumps for producing for pipe-line transmission.
4. Power air and gas compressors.
5. Produce electric power on construction work where semi-portability is desirable.
6. Produce electric power in isolated locations.

They may serve you, too, in one or more of these ways.

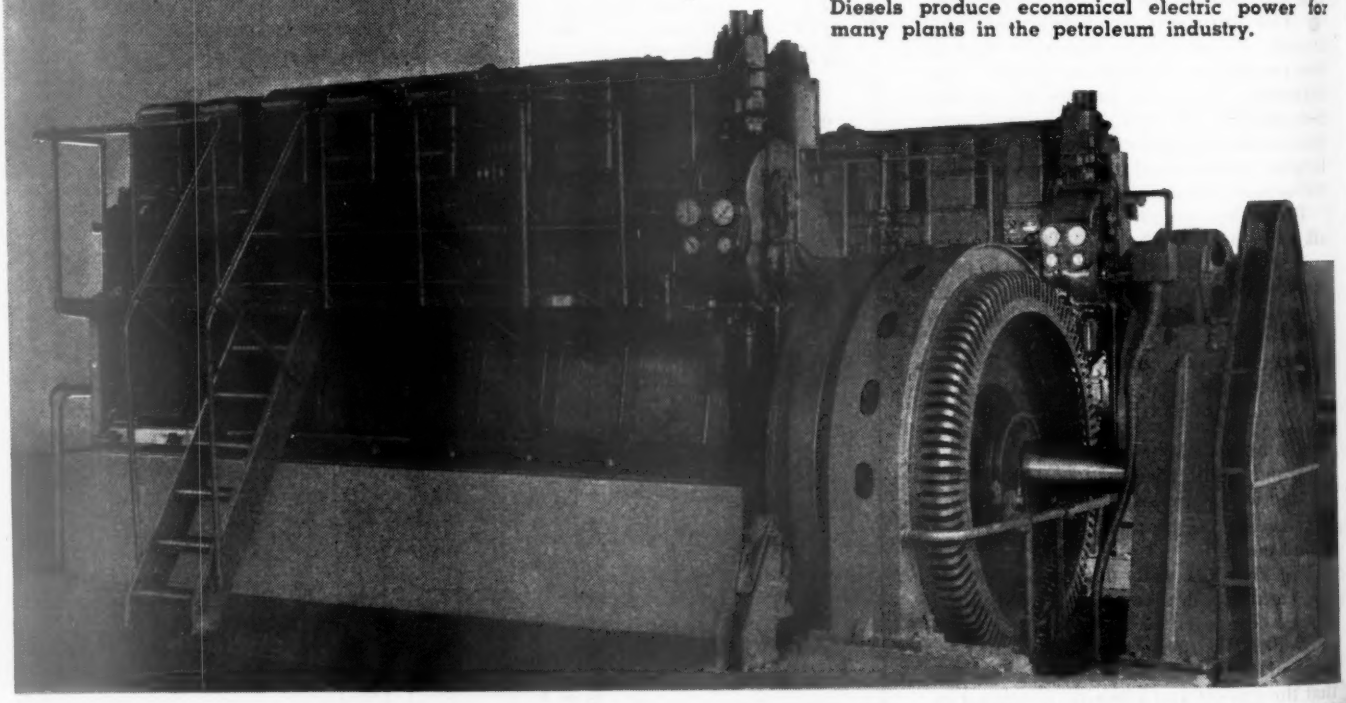
ASK any user of a Cooper-Bessemer why he likes it. Nine chances in ten he'll mention Dependability — its ability to stay on the job year after year, handling overloads or normal loads without interruption of service, with negligible maintenance.

Such dependable performance means Economy measured in low-cost operation . . . economy further emphasized by fuel saving and efficient work output resulting from good design, advanced engineering and sound workmanship.

Most Cooper-Bessemer engines and compressor units built since Pearl Harbor have been allocated to meet the most critical wartime needs — for producing aluminum, synthetic rubber, ammonia, helium, and aviation gasoline; for other vital processing operations; for natural gas transmission.

Meanwhile, the hundreds of Cooper-Bessemer Die-

Two Type JS 8-cylinder Diesels, rated 690 hp each, driving 495 kw generators. Cooper-Bessemer Diesels produce economical electric power for many plants in the petroleum industry.



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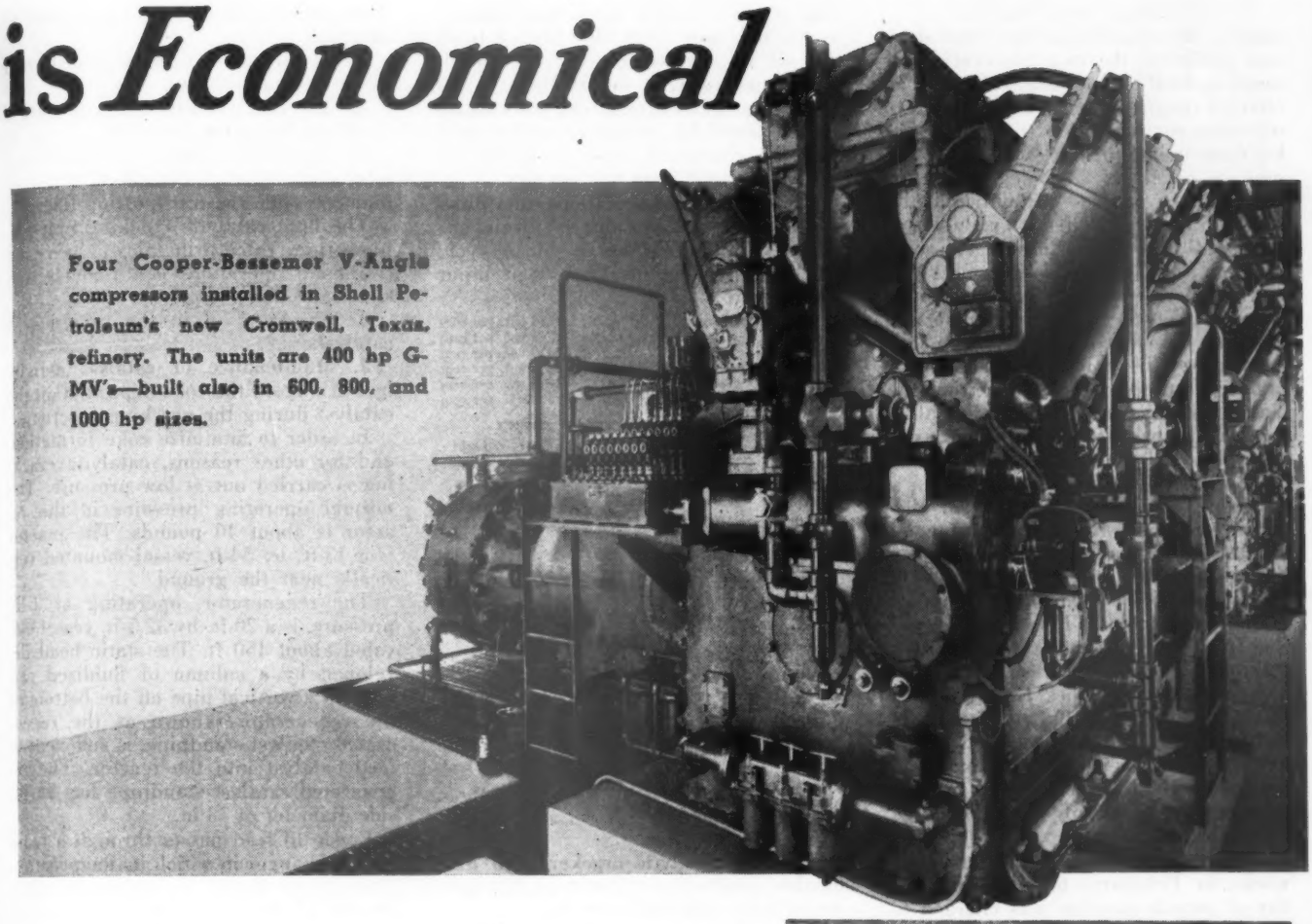

Four Cooper-Bessemer V-Angle compressors installed in Shell Petroleum's new Cromwell, Texas, refinery. The units are 400 hp G-MV's—built also in 600, 800, and 1000 hp sizes.

sels, gas engines and compressors that went to the oil, gas, and related industries before the war have continued to perform dependably, economically, under the heavier loads and gruelling conditions of wartime, often operated by personnel with little or no experience.

As war demands slacken, we are ready to supply even better engines and compressors for all our old customers, and new ones too, who want to enjoy the sure advantages of dependable, economical Diesel and gas-engine power for pumping, drilling, compressing, and for generating electricity.

It is time now to figure your needs, immediate and post-war. Your inquiry will receive our prompt attention.

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(Continued from Page 81)

satility. When sufficient fresh feed stock was available, the unit has cracked as much as 5000 bbl. per day. It has run on charges ranging from straight gas oil to mixtures containing up to 30 per cent kerosine, taking them in stride. Even Illinois gas oil as low as 33-deg. API gravity has been cracked without difficulty and with no serious effect on yields.

Operating conditions have been varied as much as charging stocks to meet special requirements. For instance, since isobutane became available from outside sources, the reactor temperature has been progessively increased to 950°F. in order to produce at the same time the maximum amount of butylene for alkylation and a base stock suitable for aviation blending without treatment other than a caustic wash.

During periods when output of 100-octane gasoline is limited by shortage of alkylate, the overall production has been increased by improving the quality of the base stock in a partial treating operation in which 400°F. end point gasoline from the receiver is returned to the reactor along with the fresh feed.

Sidecut or cycle stock from the fractionator, which usually is cracked in Dubbs No. 3, has been recycled to the catalytic reactor in order to maintain maximum yields of base stock during periods when the supply of virgin charge stock was insufficient.

For instance, during the first two weeks in February, 600-700 bbl. per day of recycle gasoline was charged to the unit, together with 4000-4200 bbl. of virgin gas oil in order to improve base stock quality. Late in February, the operation was changed. Instead of recycling raw gasoline, 750-850 bbl. per day of sidecut cycle stock was charged to the unit with 4300-4400 bbl. of fresh gas oil, in order to increase the overall production of aviation gasoline.

When sufficient fresh feed stock again became available, recycling was stopped and the charge of fresh feed was increased to 4800-5000 bbl. per day.

Yields from the operation when processing 3800 bbl. per day of virgin gas oil and 700 bbl. per day of sidecut cycle stock (calculated on fresh feed input basis) were:

Debutanized base stock	36.4 vol. per cent
Naphtha	7.1 vol. per cent
Light gas oil (cycle stock)	23.6 vol. per cent
Total C_4 fraction	26.4 vol. per cent
C_3 and lighter gases	12.8 wt. per cent
Coke	5.9 wt. per cent

Normal feed stock and quality of products

	Fresh feed	Debutanized base stock	Heavy naphtha	Light gas oil
Type: Gas oil				
Gravity	39.0	66.0	37.4	37.5
ASTM dist.				
I.B.P., °F.	387	99	338	412
10	492	116	349	485
50	575	155	360	530
90	658	284	370	600
E.P.	705	327	417	665
Sulphur wt., per cent	0.01			
Reid v.p.	9.1			
Octane number				
AFD-1C clear		80.8		
AFD-1C+4.6 cc. TEL		91.1		
AFD-3C+4.6 cc. TEL		5+0.37		

Composition C_4 Fraction liquid

	Vol. per cent
Isobutylene	12
Normal butylene	24
Isobutane	53
Normal butane	11

Had this catalytic cracker been less flexible, production of aviation gasoline would have suffered severely.

The operation of a fluid catalytic cracking unit is based on three main principles:

1. A catalyst consisting of finely divided solids will behave much like a fluid under the proper conditions of aeration.

2. The catalyst may be transported in air or vapor streams.

3. The catalyst will settle out into a dense phase when a stream of air or vapors carrying catalyst is introduced into a chamber of considerably larger diameter than the transporting line.

The fluid catalytic cracking unit employs these three principles to carry out two main operations continuously and simultaneously:

1. Cracking oil in the presence of catalyst.

2. Maintenance of catalyst activity by burning off the coke deposited on the catalyst during the cracking reaction.

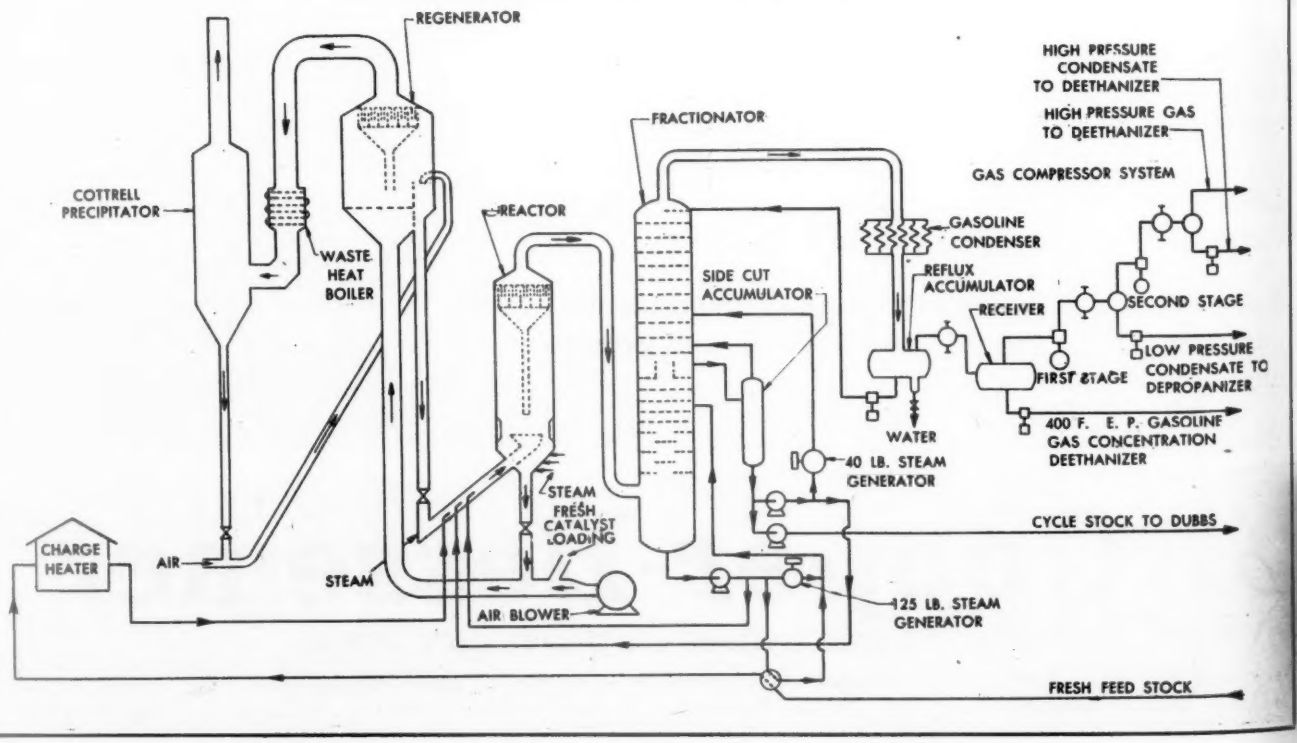
In order to minimize coke formation, and for other reasons, catalytic cracking is carried out at low pressure. The normal operating pressure in the reactor is about 10 pounds. The reactor is a 13-ft. by 54-ft. vessel mounted vertically near the ground.

The regenerator, operating at 1-lb. pressure, is a 20-ft. by 32.5-ft. vessel elevated about 150 ft. The static head developed by a column of fluidized catalyst in a vertical pipe off the bottom of the regenerator, known as the regenerated catalyst standpipe, is sufficient to feed catalyst into the reactor. The regenerated catalyst standpipe has an inside diameter of 18 in.

Fresh oil feed passes through a G-fin heat exchanger in which its temperature is raised to 300°F. by exchange with a portion of the slurry circulating stream from the bottom of the fractionator, and thence to the heater in which the temperature is raised to 750°F.

The partially vaporized charge enters the catalyst section at the line through

FLUID CATALYTIC CRACKING UNIT



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which catalyst at a temperature of 1050-1100°F. is circulated to the reactor. This line is the injector. About 1300 lb. per hr. of steam is introduced at the injector, to assist the mixing of catalyst and oil. The catalyst from the regenerator supplies the greater part of the heat required for vaporizing and cracking the charging stock. Current operation is carried out with a reactor temperature of 950°F.

The reactor temperature is largely a function of the regenerator temperature, the catalyst circulation rate, and the pre-heat on the oil feed to the reactor. A constant temperature is maintained in the reactor by minor adjustments of the catalyst circulation rate and preheat on the fresh feed, while the regenerator temperature is allowed to vary within a 50°F. range.

With a regenerator temperature of approximately 1100°F., the catalyst circulation rate is about 7 tons per min., which maintains a ratio of 15 lb. of catalyst per pound of oil.

The combined catalyst and oil vapors enter the reactor through a perforated distribution grid situated near the bottom of the reactor, and of such size that an annular space is left between the edge of the grid and the walls of the reactor. The catalyst separates into a dense phase above this grid. The vapors passing upward through this dense phase keep it agitated so completely that the bed is at a substantially uniform density.

The oil-catalyst contact time depends upon the weight of catalyst in the reactor rather than the volume, for the density of the catalyst in the dense phase may vary with other operating conditions. A constant weight of catalyst is maintained in the reactor by a controller actuating the slide valve at the bottom of the regenerated catalyst standpipe to maintain a constant differential across pressure taps at the top and bottom of the reactor. Thus a contant weight of catalyst is maintained by balancing the catalyst flow into the reactor against that withdrawn.

Most of the catalyst entering the reactor is withdrawn from the dense phase through the annular space around the inlet grid, passing downward into a conical section and thence into the draw-off line or reactor standpipe. Steam is injected at three levels around the conical section in order to strip hydrocarbon vapors from the spent catalyst. About 3000 lb. per hr. of steam is used.

Hydrocarbon vapors, steam, and some entrained catalyst pass upward through a disengaging space into a multiclone separator mounted in the top of the reactor. The multiclone is a series of small cyclone dust separators arranged to operate in parallel.

Catalyst knocked out by centrifugal action in the multiclone is returned to the dense phase through a collection hopper and dip leg. Hydrocarbon vapors carrying only a small amount of catalyst pass overhead from the multiclone to the fractionator, entering at a point just above the liquid level at the bottom.

The fractionator is an 11-ft. by 65-ft. tower containing 12 trays above a center well, and 2 trays, 2 perforated plates, and 7 perforated disk and donut pans below. Heat is recovered from the lower section by circulation of fractionator bottoms through a steam generating heat exchanger that produces 7000 lb. per hr. at 125-lb. pressure.

Oil leaving the steam generator at 400°F. is returned to the fractionator at the upper perforated tray, along with the bottoms stream from the fresh feed exchanger. This circulation of bottoms not only supplies the necessary cooling, but also provides the liquid wash for scrubbing entrained catalyst from the rising vapors.

The concentration of catalyst in the bottoms or slurry is maintained between 0.5 and 1.0 lb. per gal. by continuously returning column bottoms to the reactor via the injector.

Mid-column cooling is provided by circulating sidecut drawn from the center well into an accumulator through a low pressure steam generating heat exchanger that produces about 3000 lb. of 40-lb. steam per hr. This stream leaving the exchanger at 300°F. is returned to the column 3 trays above the center well. The sidecut or cycle stock is pumped directly to the thermal cracking unit.

The fractionator operates at a pressure of 5 lb. The bottom temperature is held at 550-575°F. and the top temperature is maintained at 225°F. by returning gasoline from a reflux accumulator to the top of the column. Water from the condensation of the steam injected into the reactor is withdrawn continuously from a leg on the reflux accumulator.

Overflow from the accumulator passes through a subcooler into a receiver from which the 400°F. end point unstabilized gasoline is pumped to the gas concentration unit, whereas the gas goes to the compressor suction drum and thence to the first stage of a 600-hp. 2-stage gas-engine driven Cooper-Bessemer compressor.

Discharge from the first stage at 50-lb. pressure passes through a cooler into a receiver. Low pressure condensate is pumped to the gas concentration depropanizer. Fifty-pound gas passes to the second stage of the compressor in which the pressure is raised to 225 lb. The second stage discharge passes through a cooler into a high pressure receiver from which the gas and high pressure condensate go to the gas concentration deethanizer.

Spent catalyst leaves the bottom of the reactor at 900-950°F., passes through a slide control valve and drops into the line through which air for regeneration is introduced. The catalyst is picked up by this air stream and carried upward into the regenerator through the regenerator riser, inside diameter of which is 36 in.

The rate of catalyst circulation is determined from the pressure differential between two points on the riser, and the circulation rate is adjusted by resetting the controller, which actuates the spent catalyst slide valve to maintain a constant differential on the riser.

The combined air and catalyst stream passes through a perforated grid into the main section of the regenerator in which the catalyst settles into a dense phase. The temperature in the regenerator is 1050-1100°F. This temperature is maintained by burning coke deposited on the catalyst during cracking. Coke on the spent catalyst amounts to 1.0 to 1.5 per cent by weight. This is reduced to 0.5 to 1.0 per cent in the regenerator.

The total quantity of coke burned in the regenerator is 30-35 tons per day. Regeneration air is supplied by a turbo-blower unit capable of delivering 11,600 standard cu. ft. at a discharge pressure of 18 lb. The air rate is controlled by adjusting a butterfly valve in the blower discharge to maintain an oxygen concentration of 2-3 per cent in the combustion gases leaving the regenerator.

Combustion gases and some entrained catalyst separate from the dense phase and pass upward through a multiclone separator mounted in the top of the regenerator. Catalyst separated by centrifugal action in the multiclones drops into a hopper from which it is returned to the dense phase through a dip leg. Regenerated catalyst is withdrawn from a hopper in the dense phase passing downward through the standpipe into the reactor to complete the catalyst circuit.

Combustion gases from the regenerator pass overhead at 1000-1050°F., through a waste heat boiler in which sufficient heat is recovered to generate 3000 lb. of 40-lb. steam per hr. The partially cooled gases are further cooled to 375-400°F. by the injection of water into the duct below the waste heat boiler.

From this duct the gases pass into a Cottrell electrical precipitator in which the catalyst particles are charged and collected on the plates of plate and frame electrodes across which a high voltage electrical discharge passes. The catalyst recovered from the plates drops into a hopper and passes downward in a small standpipe, through a slide control valve and into an air stream that carries it back to the regenerator.

Combustion gases carrying a small quantity of catalyst fines are released at the top of the precipitator. The total inventory of catalyst in the unit is approximately 125 tons, of which 35 tons is above the grid in the reactor and 55 tons above the regenerator grid. The catalyst replacement on this unit amounts to approximately 1 ton per day.

In order to minimize the use of alloy steel the wheels and lines in service over 1000°F. are internally insulated with 4 in. of soft insulating block and 3 in. of Bigelow-Liptak refractory tile.

The catalyst used presently is a synthetic silica-alumina having an average particle size of about 22 mesh. Natural, or Filtrol catalyst was used in a 12-day trial run when the unit was first put into operation. ★★★

(The second and concluding article on the Pennzoil refinery will be published in an early issue.)

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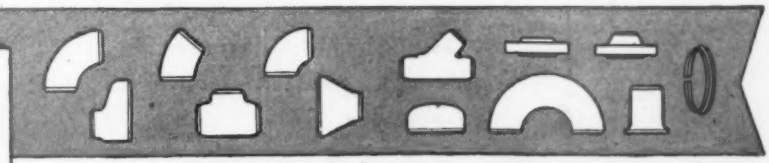
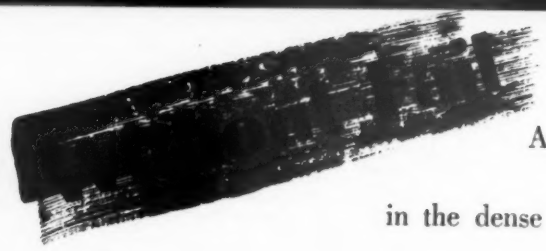
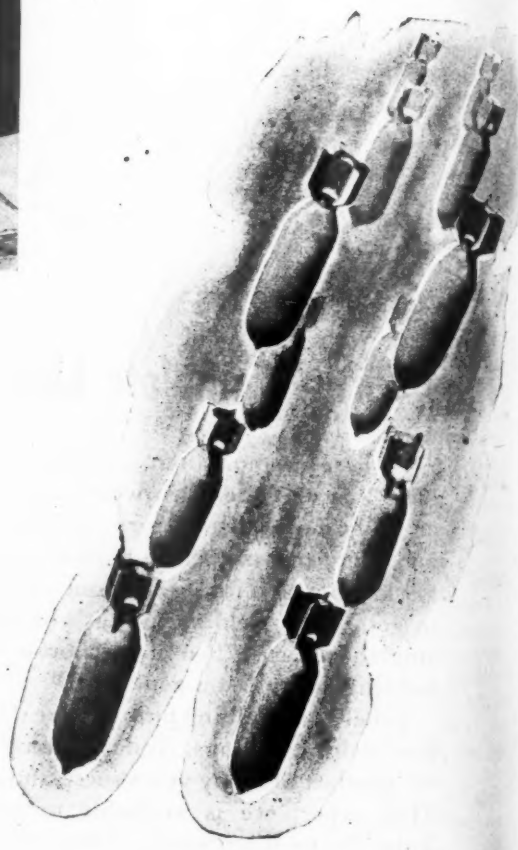


THE COMPLETE LINE OF WELDING FITTINGS AND FLANGES



A group of Allied tanks were hopelessly lost in the dense Burma jungles. For their assignment these airmen were to find the lost tanks and guide them back to their base. This is how it was done: on their return from searching out Jap supply dumps and airdromes fliers made pictures of the lost tanks and the surrounding countryside and marked on the shots

the best ways for them to rejoin other Allied forces. They repeated the performance of swooping in low over Jap forces and dropping photos by chutes to the tanks until they were safe.



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MUD PUMP MANIFOLD FACILITATES DRILLING

By **WALLACE A. SAWDON***

EXCLUSIVE GREAT strides have been made in consolidating rig equipment in the last decade. This has resulted in the saving of much material during the last few years of material shortage when this particular factor was most important. As much attention, however, has probably not been given to some of the auxiliary equipment in constant service around the rig, and such items as lines and valves have not been conserved to the extent that they might have been. An example of what can be done to save material and increase operating efficiency is the unitized manifold for mud pumps developed by the Continental Oil Company in California. This manifold design was first developed several years before the war and thus fitted in with the material conservation program when it was put into effect. The one herein described and illustrated replaces the first one that was built in 1934 and which has been in continuous service for more than 10 years.

Of greater importance than the saving of material, particularly in the years to come when pipe and valves will not be so hard to obtain, is the greater efficiency resulting from the use of the standardized manifold. Yet the industry has learned that savings can be made by intelligent planning and that wasteful use of material is probably a thing of the past. Permanently assembled units that can be used again and again will be increasingly employed and every assembly of this character is of importance. The permanent manifold for the mud system will not only save pipe and fittings but, when properly designed, will save time while rigging up and during drilling operations.

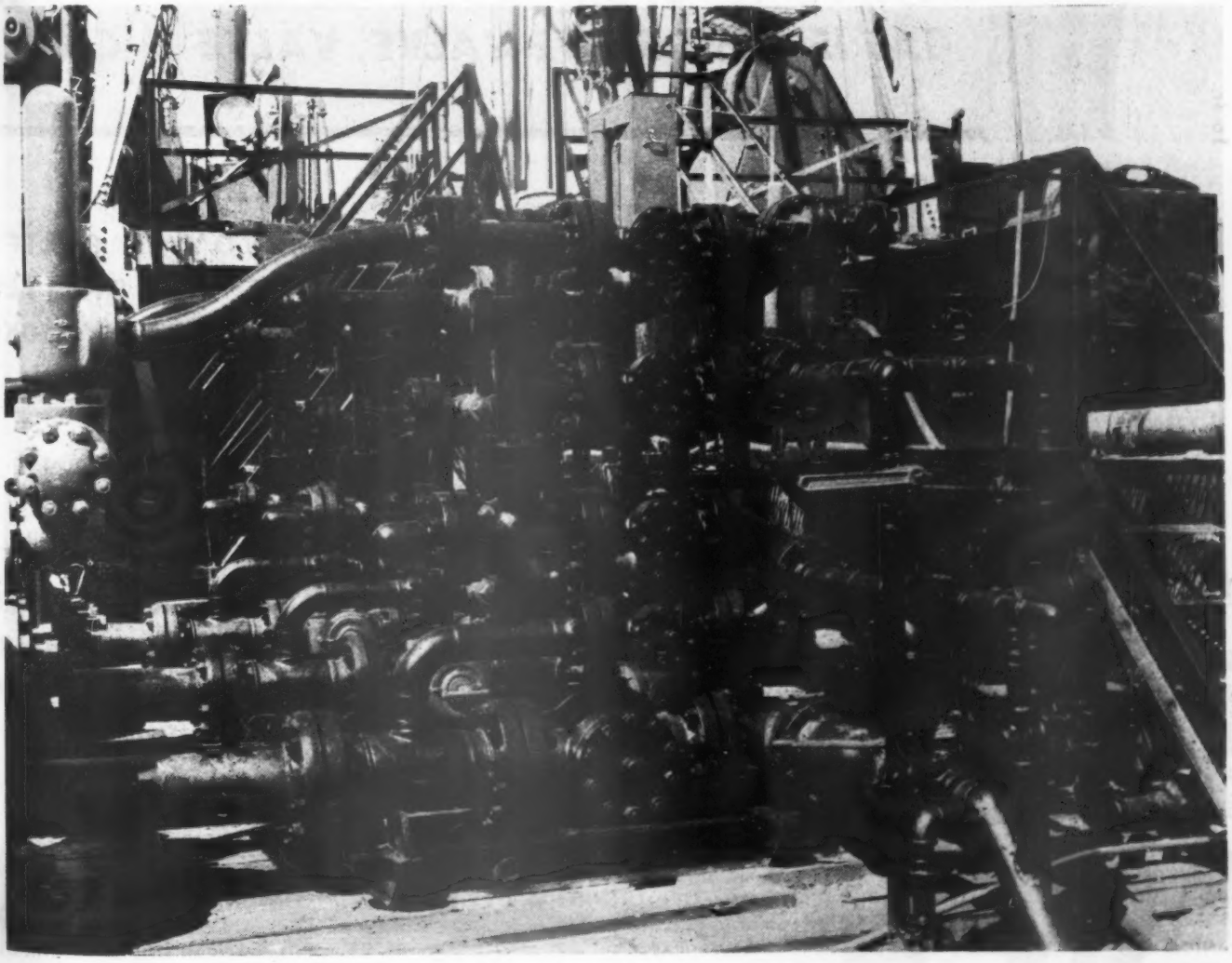
From the operating standpoint there are many advantages that have been observed by use of the standardized manifold. When a well is being rigged up the necessary lines to and from the pumps will be laid. Then other lines will be found necessary and as time goes on conditions may require a complexity of lines that will result in possibly only one man knowing just which lines go where and what valves control certain flows of fluid. In contrast to this, the manifold here shown has been standardized and the same design used on all rigs. Roughnecks, once they learn its operation, can go to any rig and know exactly what to do. The original manifold was stenciled with flow directions but it has been found that these were unnecessary after the men became familiar with the manifold.

The installation shown in the accompanying photographs is on a Continental Oil Company well in the San Miguelito field, California. The manifold serves

(Continued on Page 93)

*Wallace A. Sawdon is editor of *Petroleo*, Los Angeles, California.

The manifold in service on a well of Continental Oil Company in the San Miguelito field, California.



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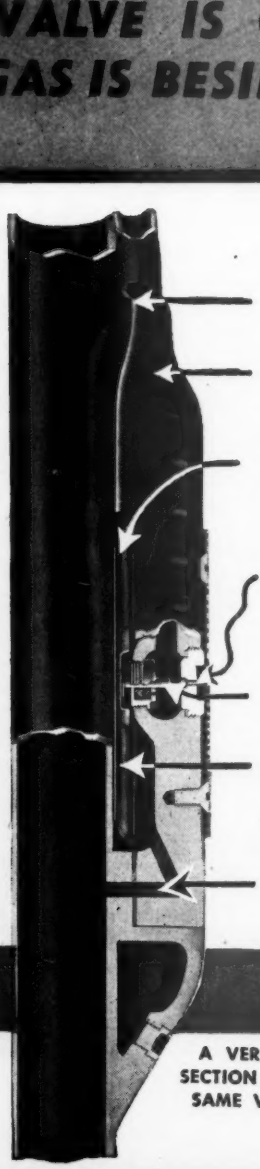
A PHANTOM VIEW OF THE VALVE AT AN ANGLE



A VERTICAL SECTION OF THE SAME VALVE.

- "LIGHT OIL" TUBE.
- GAS LIFT BODY.
- PORT CONDUCTING "LIGHT OIL" TO BACK SIDE OF DIAPHRAGM.
- ORIFICE ADMITTING GAS FROM CASING ANNULUS.
- ORIFICE PIN (VALVE).
- DIAPHRAGM ASSEMBLY.
- PORT PERMITTING ENTRANCE OF WELL FLUID TO FRONT SIDE OF DIAPHRAGM.

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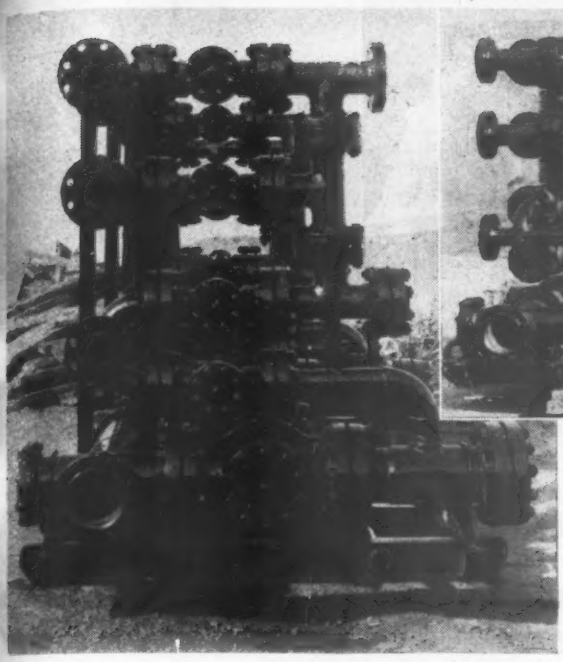
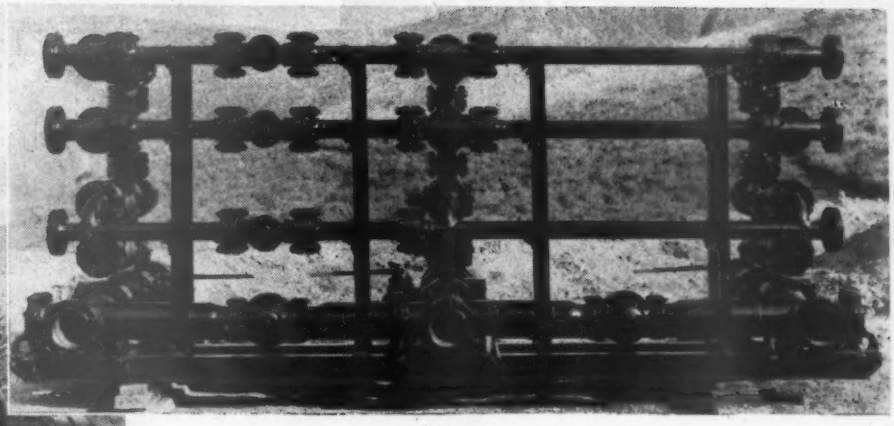




Left—End view of the manifold.

Right—Front view of the manifold showing the assembly ready for installation behind the pumps.

(Continued from Page 89)

three pumps, two main mud pumps, and one transfer pump. Four headers provide one suction line, one compound line, and two discharge lines. Circulation in the well and mixing of mud can be carried on at the same time. All operations of the mud system—from the mud storage to the well—are facilitated; even clean water can be pumped to follow up cement if desired. Mud mixing and mud transfer time can be saved. Vibration is absorbed by rubber hose on the suction lines and an S-bend of hose is placed on the discharge line before it connects to the standpipe.

The manifold is skid mounted as one unit and is readily transported to a new location after the well at which it has been used is completed. A steel structure welded to the base supports the four headers, as can be seen in the illustrations. The skids consist of 4-in. I-beams with eye connections at each corner for fastening slings or winch lines. The entire unit for handling three pumps is 17 ft. 7 in. in length, 6 ft. 4 in. in width and 7 ft. 4½ in. in height.

The manifold is flanged throughout for ease in removal of worn parts. Flanged tees, with one side plugged, provide means for washing out mud and cuttings at points where settling can take place. Copper metal asbestos gaskets are employed at all flanged joints.

The large bottom header is the 8-in. suction line, with the three connections to pumps clearly indicated in the front view of the manifold. Pump suction fittings are 8-in. Series 150. The compound suction fittings are 6-in. Series 600 and the discharge connections are 4-in. Series 900.

All valves are of the lubricated plug type and those exposed to high velocity and pressure are specially coated. The valves in the assembly consist of:

Two 6-in. Series 150 wrench operated block valves in the suction line;

Three 8-in. Series 600 gear-operated compound valves in the suction line, and

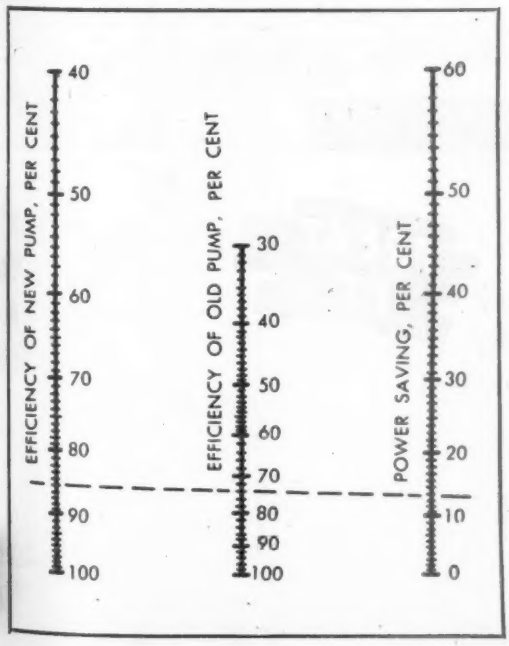
Fifteen 4-in. Series 900 wrench operated specially coated valves in the discharge lines.

The piping is 4-in. extra heavy seamless Grade A line pipe and extra strong. Long-radius welded ells are used in the discharge piping. ★★★

P 094.86

INSTALLING A MORE EFFICIENT PUMP

W. F. SCHAPHORST



IF THE efficiency of your present pump is 74 per cent, and you are planning to install a pump the efficiency of which will be 85 per cent, the improvement will not be merely 11 per cent. There will be an improvement of 13 per cent in efficiency.

It is not uncommon for users and prospective users to subtract the efficiency of the old pump from that of the new and call the difference the "improvement" in efficiency, but that is not correct. The correct method is to subtract the two and then divide the difference by the efficiency of the new pump.

Thus, for example:

$$0.85 - 0.74 = 0.11$$
$$0.11 \div 0.85 = 0.13$$

which proves the figures mentioned above.

Suppose that you have a pump whose efficiency is only 40 per cent and you are contemplating the installation of one whose efficiency will be 80 per cent. The difference between the two efficiencies is 40 per cent, but that is not the correct improvement. The true improvement is $40 \div 80 = 50$.

Shown here is a chart that gives the true improvement or "power saving" without any longhand figuring whatever. Simply run a straight line through the efficiency of the new pump, column A, and the efficiency of the old pump, column B, and the power saving or improvement in efficiency is instantly given in column C. Thus the dotted line drawn across this chart shows that where the efficiency of the new pump is 85 per cent and that of the old pump 74 per cent, the improvement, or power saving, is 13 per cent. As another example, suppose the old pump efficiency was 53 per cent and the new pump efficiency 70 per cent. A line drawn through these two points shows that the power saving is about 24 per cent, and not just the difference of 17 per cent between these two efficiencies. ★★★

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EXPLOSIVE MIXTURES IN AIR DRIVE OPERATION

By R. F. NIELSEN* and S. T. YUSTER*

EXCLUSIVE WHEREVER air is used as the repressuring or driving medium in secondary recovery, there is the possibility that the gaseous mixtures produced along with the oil are within the explosive range. Various precautions and safeguards are being employed or have been suggested to prevent serious accidents. There include periodic analyses of the gases, safety blow-out diaphragms on the gathering and compressor equipment, and automatic devices that give warning or shut down the plant in case the compressor intake becomes within explosive limits.[1]

● **Effect of variables on explosive limits.** The explosive limits of combustible gases, that is, the maximum and minimum percentages of the gas with admixed air that will allow flame propogation, have been studied by many investigators. A summary and references may be found in the books "Combustion, Flames, and Explosions of Gases," by Lewis and von Elbe[2], and "Flame and Combustion in Gases" by Bone and Townsend[3]. These limits vary widely with the chemical nature of the inflammible compound or mixture of compounds, as the case may be. The limits are affected somewhat by temperature, pressure, the size and shape of the containing vessel, and by whether flame propagation is up or down. The effects of most of these variables are not large for hydrocarbons. For instance, at 400° F. the range for methane is 5 to 14 per cent as compared with 6 to 13 per cent at room temperature. Pressure has very little effect on the lower limit but the percentage at the upper limit for light hydrocarbons is increased by about unity when the pressure is increased from atmospheric to 75 lb. gage. That is, the upper limit for methane is increased from 13 to 14 per cent, the upper limit for ethane from 10 to 11 per cent, etc. The size of the vessel makes little difference except in the case of small tubes less than an inch in diameter. Whether propagation is upward or downward—that is, whether the point of ignition is near the bottom or the top of the vessel—has a considerable effect on the upper limit but only a small effect on the lower limit. This is shown in the following table taken from the literature:

	Downward		Upward	
	LL	UL	LL	UL
Methane	6	13	5.4	14.5
Ethane	3.3	10	3.2	14.8
Pentane	1.5	4.6	1.4	8.0

As would be expected, the limits are greatly affected by the presence of an inert diluent such as carbon dioxide. water vapor, or nitrogen (in excess of that contained in the admixed air). This is shown in Figs. 1, 2, and 3, plotted from the data of Jones and Kennedy[4]. Fig. 1 gives the lower limits for methane, ethane, propane, butane, and pentane, at room temperature and atmospheric pressure, with various amounts of nitrogen. The ratio excess nitrogen/hydrocarbon is plotted horizontally, and the minimum percentage of this hydrocarbon-nitrogen mixture that must be added to air to form an explosive mixture is plotted vertically. As stated above, the lower limits are about the same for upward and downward propagation. Fig. 2 is a similar set of curves for the upper limits for downward propagation, and Fig. 3 shows the upper limits for upward propagation.

● **Calculation of explosive limits of lease gases from composition.** For a number of reasons it is better to know how far the mixture collected from the casing of a producing well is from the explosive limits than merely to know whether or not it is explosive. If the gas is to be recycled, some allowance must be made for the temperature and pressure reached in the compressor, and, besides, a certain amount of make-up air is often added to the recycled gas. Also, the percentage of oxygen gradually increases with time, due to the increase in the conductivity of the sand to air as the oil and water are removed.

The method of calculating the explosive limits from the composition will be illustrated with three samples collected in the Venango area. The results will be compared with the limits actually obtained with a simple field explosimeter described below. The compositions of the samples were as follows:

Sample No.	1	2	3
Carbon dioxide	2.2%	0.5%	1.7%
Oxygen	6.3	9	17.6
Hydrocarbons	46.1	15	7.0
Nitrogen	45.4	75.5	73.7

These samples all contained air as well as excess nitrogen, that is, more nitro-

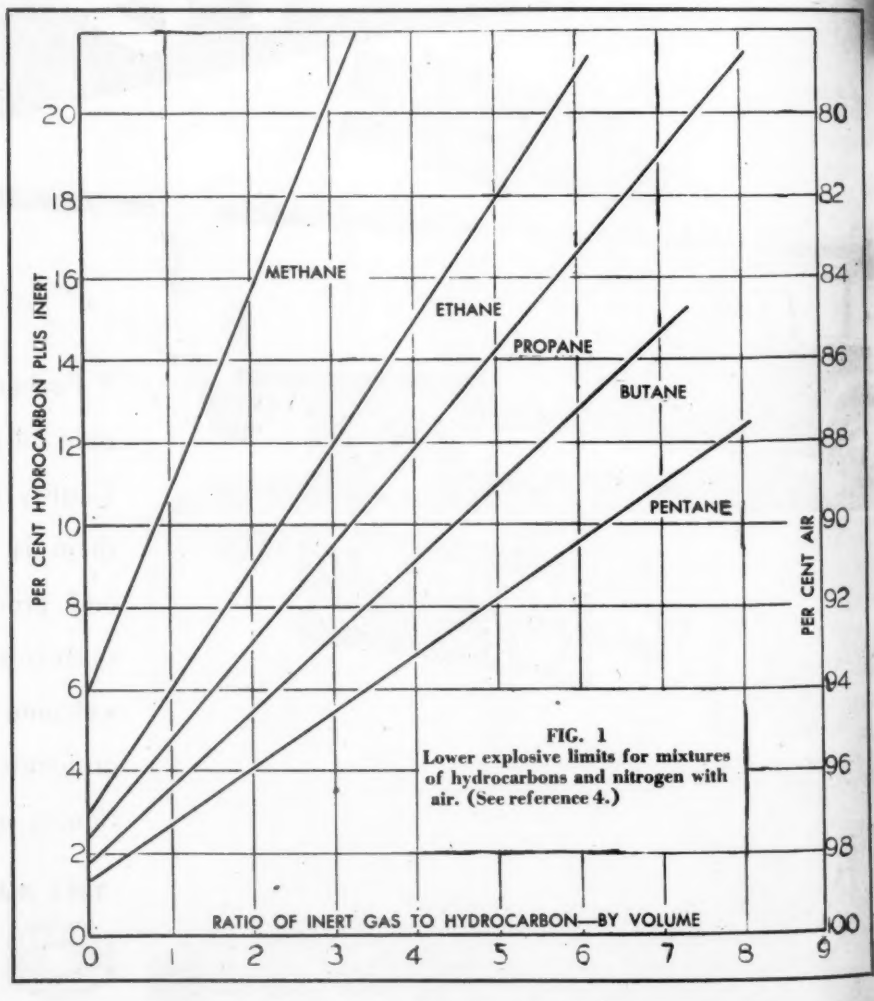

FIG. 1
Lower explosive limits for mixtures of hydrocarbons and nitrogen with air. (See reference 4.)

*Department of Petroleum and Natural Gas Engineering, The Pennsylvania State College, State College, Pennsylvania.

[1]References at end of article.

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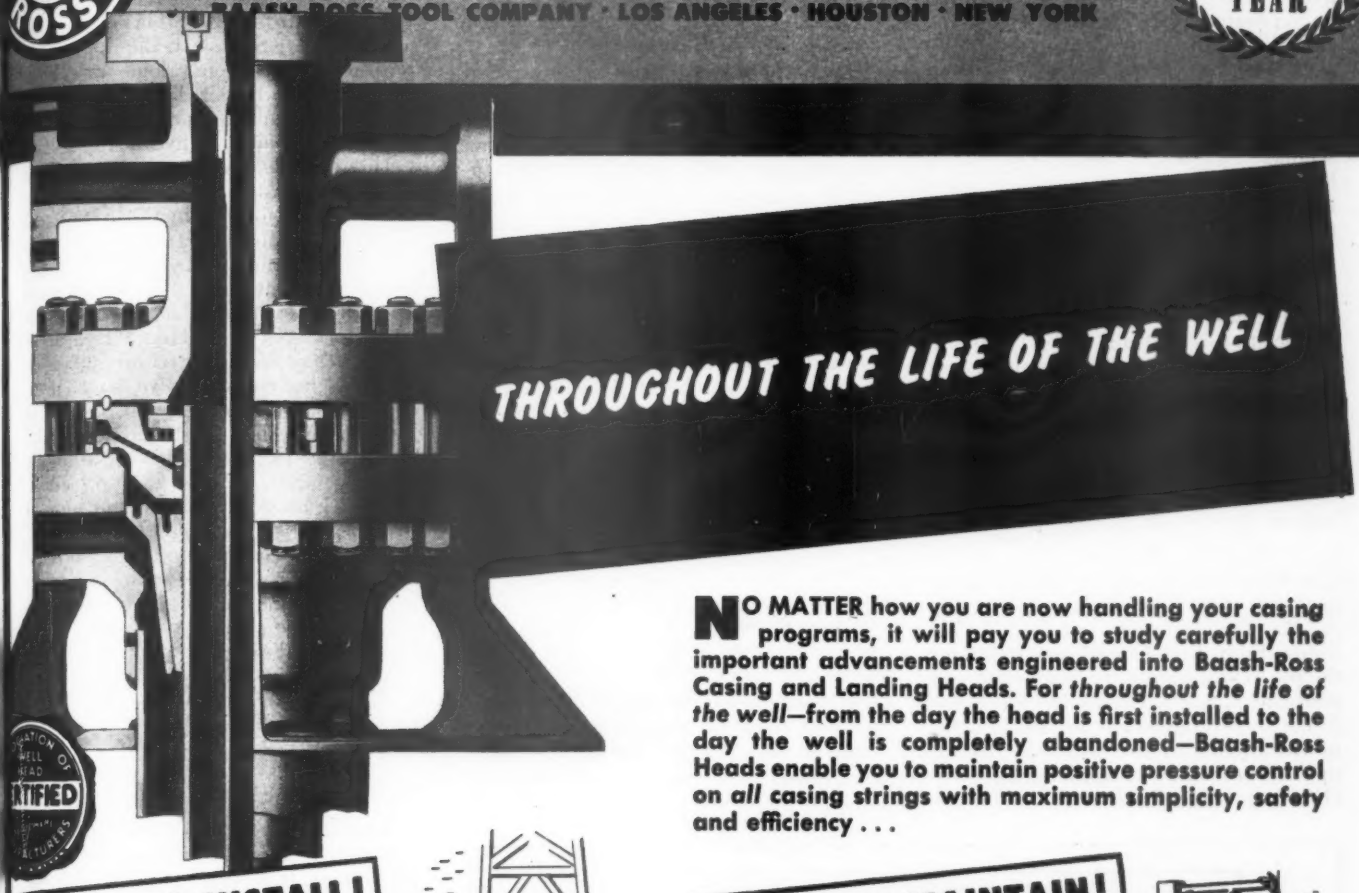

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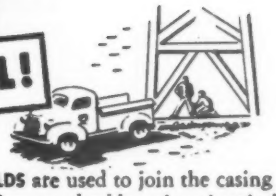

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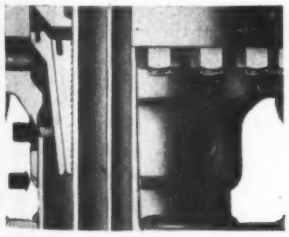

2. **STRONGER WELDS** are also assured by another Baash-Ross design feature. Note that the support flange is specially engineered with a wall section approximately equal to that of the casing. This insures uniform heat distribution between casing and flange when welding, resulting in a better, stronger weld than is possible with conventional thick-bodied heads.

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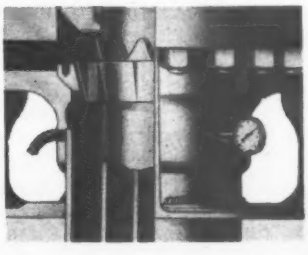
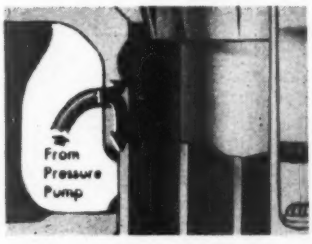
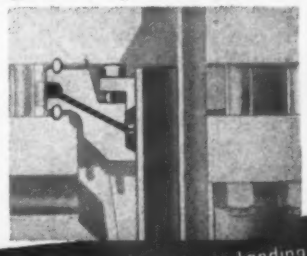


SAFER TO MAINTAIN!

4. **QUICK PACK-OFF** of any leaks that might develop over the years that the head is in service is provided by another unique feature. At any time during the life of the well the welds can be quickly re-tested for pack-off. If leaks are discovered there's no need to dismantle the head . . . kill the well . . . or even break connections. Simply pump plastic packing in through the threaded ports, thus filling the annular space between the welds and sealing off *all* leaks, small or large.



5. **SUCCEEDING STRINGS** also have the same lifetime control features. Note how packing element for succeeding strings has an annular space between packing rings. Outside ports connect to this channel so that the pressure seal can be quickly tested after installation. Moreover, *at any time during the life of the well* any string can be individually re-tested and leaks plastic-packed. There's no need to disturb the well or even break connections. It's far safer, too, because no re-welding is necessary. Welding is always dangerous around a well on production!



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gen than could be accounted for on the basis of the normal oxygen/nitrogen ratio in air. It is first necessary to calculate what the explosive limits of the hydrocarbon portion would be if it could be separated and mixed with air. The analysis of the hydrocarbon portion is as follows, as determined by the usual low temperature fractionation method:

Sample No.	1	2	3
Methane	26%	6%	10%
Ethane	34	7	12
Propane	22	35	41
Butanes & heavier	18	52	37

A formula which gives approximately the explosive limits of a mixture of combustible gases from a knowledge of the composition is that due to Le Chatelier. If a, b, c, d, etc., are the percentages of the various constituents by volume, and A, B, C, D, etc., the explosive limits of the respective constituents when taken alone, then the explosive limit of the mixture is:

$$\frac{100}{\frac{a}{A}+\frac{b}{B}+\frac{c}{C}+\frac{d}{D}\text{ etc.}}$$

The formula applies to either the upper or lower limit, depending on whether A, B, etc., represent upper or lower limits. From Fig. 1, the lower limits for the pure constituents are, beginning with methane, 6, 3, 2.4, 1.8. From Figs. 2 and 3, the upper limits are 13, 10, 7, 5 for downward and 14.5, 12.5, 9.5, 8.5 for upward propagation. Applying Le Chatelier's equation, the lower limit for the hydrocarbon part of Sample 1 is

$$\frac{100}{\frac{26}{6}+\frac{34}{3}+\frac{22}{2.4}+\frac{18}{1.8}}=\frac{100}{4.33+11.33+9.15+10.00}=2.9$$

Similarly, the upper limit for downward propagation is 8.2 and for upward propagation 11.0. The calculated limits for Sample 2 are 2.1, and 6.0 and 9.3, depending on whether propagation is downward or upward, and for Sample 3 are 2.3, and 6.6 or 9.7.

To allow for the excess nitrogen, the analyses must be recalculated so that the nitrogen percentage is distributed between the air already in the sample, and nitrogen in excess of that due to the normal oxygen/nitrogen ratio in air. Assuming dry air to be 21 per cent oxygen and 79 per cent nitrogen, the nitrogen calculated to air is 79/21 times the oxygen percentage, and this plus the oxygen is the per cent air. The remaining nitrogen and the carbon dioxide are lumped together and called "excess inert gas":

Sample No.	1	2	3
Air	30.0%	42.8%	83.8%
Hydrocarbons	46.1	15.0	7.0
Excess inert gas	23.9	42.2	9.2
Ratio inert/hydroc.	0.5	2.8	1.3

It is apparent (see Fig. 1) that Sample 3 already contains enough air to be close to the explosive limits. The other two samples also contain considerable air, but are not so close to the limits. It is desired to know how much more air can be added before the mixtures become explosive. To see how much air the mixture of hydrocarbon and inert can stand before becoming explosive (by downward propagation), use is made of Fig. 2. For Sample 1, the upper limit for the hydrocarbons alone was calculated above to be 8.2. This point lies between the ethane and propane curves for zero ratio of inert to hydrocarbon. Following parallel to the curves up to a ratio of 0.5 gives 11 per cent as the explosive limit for the hydrocarbons and inert. The sample contains 70 per cent of combined hydrocarbons and inerts and 30 per cent air so that enough more air will have to be added to bring this down to 11 per cent. Thus, 11 cu. ft. of hydrocarbon and inert require 89 cu. ft. of air to become explosive, so 1 cu. ft. of sample, which contains 0.7 cu. ft. of hydrocarbon and inert should require $.7/11 \times 89$ (minus the 0.3 cu. ft. of air already there) or $5.7 - .3 = 5.4$ cu. ft. The calculations are similar for upward propagation and for the "lower limits." The calculated limits for all three samples are given in the following table, which gives the limiting volumes of air to one volume of sample to make an explosive mixture:

Sample	Upper Limit		Lower Limit
	Downward	Upward	
1	5.4	3.8	16
2	2	1.6	7
3	0.2	—0.1	2

According to the calculations, Sample 3 in very near, if not within, the explosive range. It is quite possible that the sand where this sample was taken has a loose streak through which air can move relatively fast, a theory further substantiated by the fact that the casing pressure at this producer built up very quickly when the valve on the gathering line was closed.

The calculation of the explosive limits for lease gas samples such as these may be made almost as well, if not just as well, considering the inherent errors, from an Orsat analysis alone. From a good Orsat analysis it is possible to obtain the average molecular weight of the hydrocarbon portion of the gas, that is, to determine whether the average lies between ethane and propane, etc. By interpolating this on the curves, the explosive limits so obtained for the hydrocarbon portions alone will be sufficiently close to those obtained from Le Chatelier's equation, which requires a complete fractionation of the hydrocarbons. The rest of the calculation—that is, allowance for air and excess nitrogen—is the same as given above.

The analyses were examined as to whether the heats of combustion might be any indication of how far the mixtures are from the explosive range. There are two main reasons why this is not considered much of an indication. First, it is not possible by this means alone to tell how much of the non-combustile portion is nitrogen and how much is oxygen. Second, the limits (in particular the upper limits) for the various hydrocar-

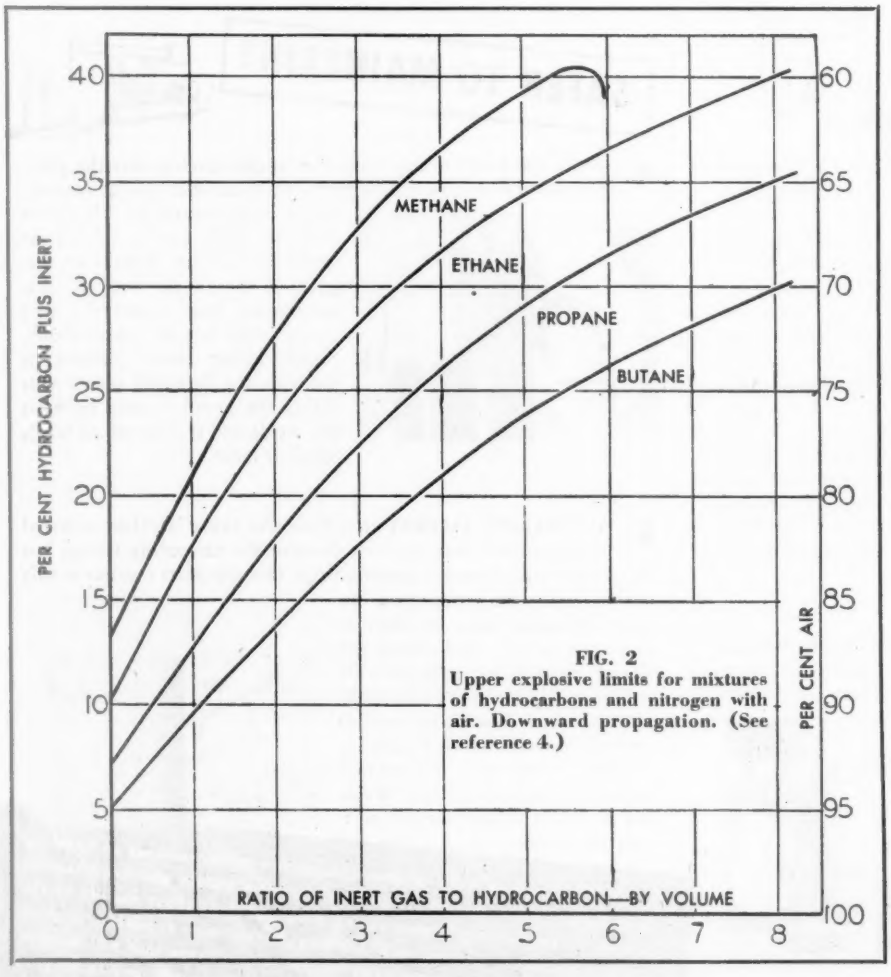
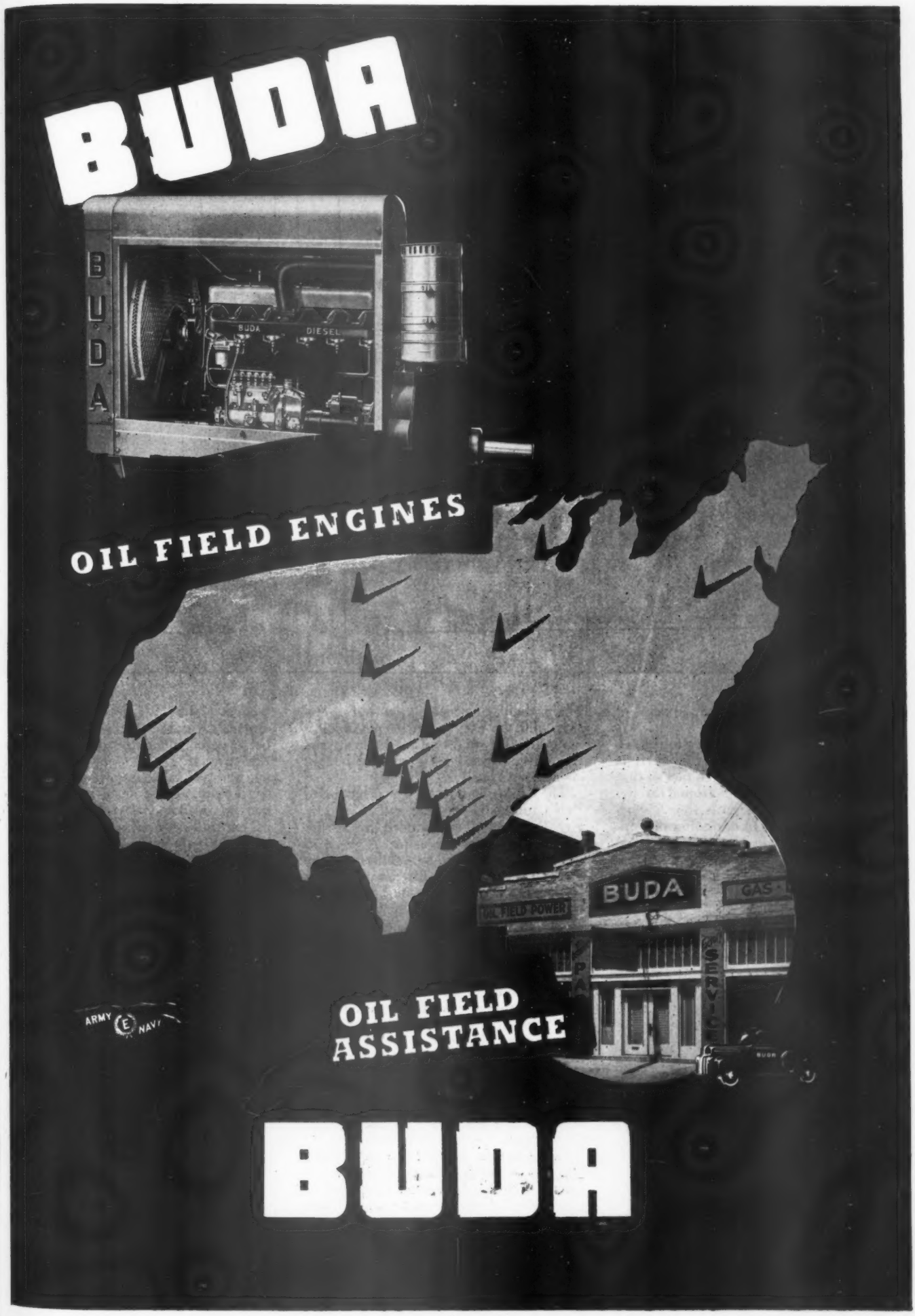


FIG. 2
Upper explosive limits for mixtures of hydrocarbons and nitrogen with air. Downward propagation. (See reference 4.)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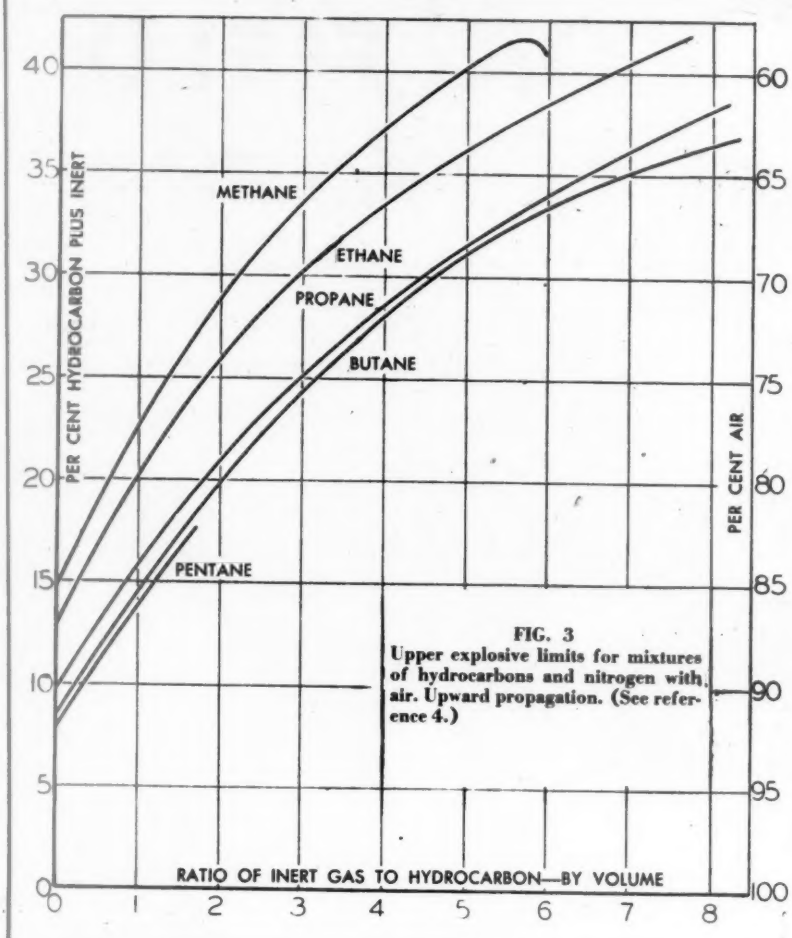


FIG. 3
Upper explosive limits for mixtures of hydrocarbons and nitrogen with air. Upward propagation. (See reference 4.)

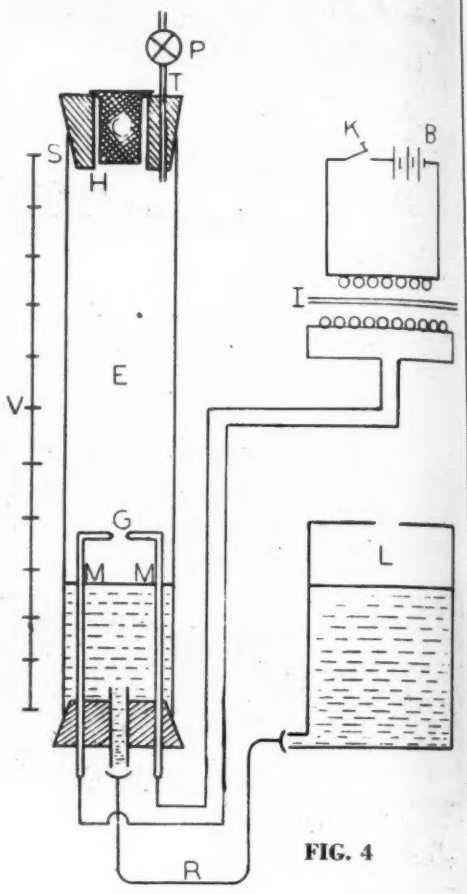
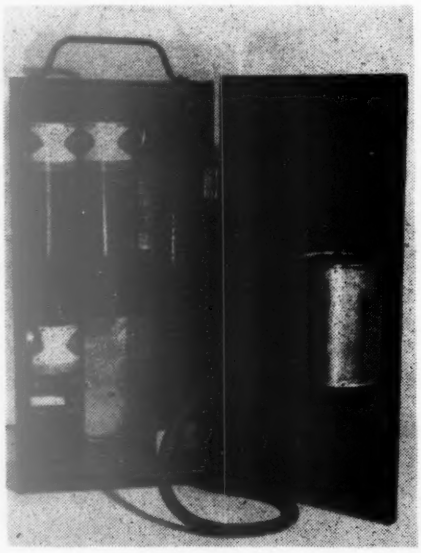


FIG. 4

bons are not proportional to the heats of combustion.

An apparatus used for testing gases in the field is pictured in Fig. 5. It is assembled in a small wooden box so that it can easily be carried around in the field. The general design is shown schematically in Fig. 4. In designing this apparatus, primary consideration was given to simplicity of construction and operation, and the use, as far as possible, of materials that might be available around the lease, or at least could be bought cheaply and easily.

FIG. 5. Apparatus for determining explosive limits of lease gas.



The explosion burette E is a section of Pyrex tubing 11 in. long and 1½ in. internal diameter, surrounded by a wire screen as a safety measure. A piece of safety glass could be substituted for the screen. The burette is fitted with rubber stoppers SS at the top and bottom. A large hole H is drilled in the top stopper and fitted with a short section of glass or metal tubing which is flush with the under side of the stopper but projects slightly above the top side. A cork C is made cylindrical and the top edge beveled and fitted with a rubber gasket. This cork is made about ⅛ in. smaller in diameter than the inside of the glass or metal tube. The top edge of the tube is smoothed or fire polished so that it fits the beveled edge of the cork. Near the edge a piece of ⅛-in. copper tubing T attached to a pet cock P is run through the stopper.

In the bottom stopper is a short piece of glass or copper tubing to which the rubber tube R is connected. The leveling can L was made by soldering a short piece of metal tubing to an ordinary tin can. The hole in the top is small enough so it can be stoppered during transportation. The ignition system is composed of a key or push button K, batteries B, induction coil I, and spark gap G. A coil from a Model T Ford was used in the apparatus of Fig. 4. Two pieces of rubber covered metal rod or wire MM are run through the stopper and are bent and scraped at the upper end to form the spark gap. These may be made from heavily insulated wire, about 16 gage, by carefully removing the outer covering. The exposed metal should be covered with a film of beeswax, except at the sharpened points, in order to make the water drain off when the level is lowered. The spark gap was put near the bottom of the burette instead of near the top because the explosive range is wider for upward propagation.

The operating procedure is as follows: After the water level is brought to the top of the burette by setting or hanging the leveling can at the proper height, gas is forced in through the pet cock. During admission of gas, the leveling can is left at this height, giving a slight pressure on the entering gas, while the beveled cork is held down tightly by hand. When enough gas has entered, the pet cock is closed and any excess gas let out by momentarily reducing the pressure on the cork (since the water level in the can is still above that in the burette). The can is now set on a predetermined lower level, and air let in to equalize the levels. Mixing of the air and gas is accomplished by repeatedly squeezing the rubber tube so as to agitate the water surface violently, the cork being meanwhile held down tightly. After the hand is re-

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moved from the cork, the mixture is tested with the spark. The explosive limits are found by taking various ratios of gas to air, to determine which relative amounts explode when the spark is passed.

With this apparatus it was possible to check the theoretically calculated limits for Sample 1 quite well, that is, 4 and 18 were obtained for the limiting volumes of air that would produce an explosive mixture with one volume of sample. In the case of Samples 2 and 3, the "upper limit" (least amount of air) agreed quite well with the calculated. Sample 2 was found to require about 2 volumes of air and Sample 3 about 1/5 of a volume. The lower limits (maximum amounts of air) found for Samples 2 and 3 were somewhat below the theoretical. The upper limits, however, are of chief interest, since the mixtures encountered in the field normally contain too little air to be explosive.

According to the table of calculated limits, Sample 3 should be spontaneously explosive for upward propagation. In the case of samples near the explosive limit, however, such as Sample 3, the calculation involves subtraction of two numbers nearly alike, so that a small negative value, such as —0.1 in this case, must not be taken as evidence that the mixture is explosive under atmospheric conditions. Considering the small amount of air needed, and the effect of pressure discussed previously, there can be no doubt that this mixture is dangerous at least under pressure. Also, no attempts were made to correct for water vapor present as a result of measuring volumes over water, since the correction would be small and probably not justified in view of other inherent errors.

Since these tests and calculations are made at atmospheric pressure and temperature some allowance must be made if it is desired to know the explosive limits at higher pressures and temperatures, such as those in the compressor. An idea of the magnitude of these corrections, which, in general, are small, was given at the beginning of the paper.

● **Summary.** The possibility that the gases produced along with the oil in air drive operations may be within the explosive range is discussed. The method of calculating the explosive range from the chemical analysis is illustrated with three different samples of casinghead gas, one of which was very near the explosive limit. A simple field apparatus, made from easily available materials, for determining the explosive limits, is described, and the measured limits shown to agree reasonably well with the calculated values.

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AUTOMATIC SCRAPERS USED IN WEST EDMOND OIL WELLS

By **K. MARSHALL FAGIN,** *Field Editor*

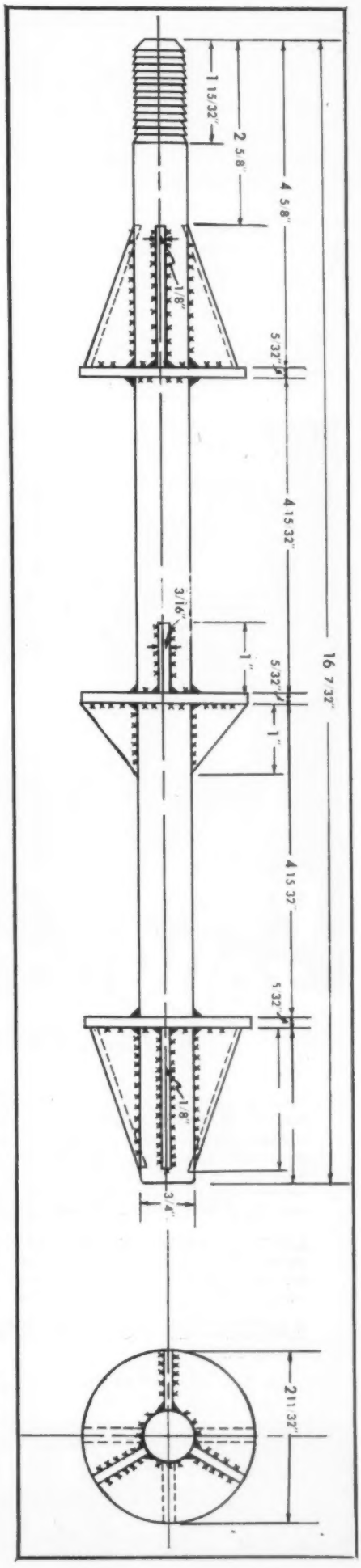
EXCLUSIVE AN INCREASING amount of trouble, delay, and expense due to the deposition of paraffin in the tubing has led a few of the larger operators in the West Edmond field to equip their flowing oil wells with automatic paraffin scrapers. The one shown in Fig. 1 is designed for use in 2½-in. tubing. The device, commonly called a "chuckler" or "go-devil," has been used effectively for many years by some operators to control paraffin deposition in wells in other areas, such as East Texas, West Texas, the Gulf Coast, and other parts of Oklahoma. It is credited with satisfactory performance in keeping the tubing open and saving the expense of special paraffin cleanout crews on most wells in which it was properly installed and operated on a regular schedule.

● **Paraffin interfered with West Edmond pressure surveys.** Early in the life of some of the West Edmond wells paraffin deposits in tubing prevented the running of bottom hole pressure bombs. Due to paraffin deposits in the tubing, pressure information was not obtained on one out of 16 key wells in the March, 1944 survey; 3 out of 34 wells in the May, 1944 survey; 2 out of 18 wells in the May 22, 1944 survey, and 9 out of 52 wells in the August, 1944 survey. Only two of the 84 key wells selected for the November, 1944, survey were reported inaccessible on account of paraffin, but this was due largely to cleaning out the paraffin in advance of the survey rather than to a decrease in deposition.

● **Design and construction.** The scraper is designed to fit loosely in the tubing and to weigh enough to drop freely through the fluid when the well is closed in. The largest diameter of the scraper should be an average of the inside diameter and the drift diameter of the tubing in which it is to be used. The three washershaped fins are slipped on a rod and welded in place as shown in the drawing. Three angle braces are welded to the top and bottom fins, and four angle braces are welded to the center fin for reinforcement. A fishing neck is provided on the upper end of the device to permit removal from the well in case it becomes stuck or the well pressure becomes insufficient to flow it back to the Christmas tree. The fishing neck on ⅝-in. rod used for 2-in. tubing scrapers should be upset to ¾-in. to insure an adequate grip.

● **Bypass aids cleaning.** Wells to be equipped with these automatic paraffin scrapers are provided with a short lubricator on top of the flow string. A spring or rubber stop is fixed in the bull plug on top of the lubricator to cushion the scraper when it flows to the surface. A bypass pipe with a full opening valve connects the lubricator directly with the flow line. This permits the regular flow connections with a positive or adjustable producing choke to be closed while the scraper is being flowed up to the surface.

● **Precautions and method of operation.** The tubing should be carefully cleaned and the bottom cross-barred before installing the scraper to insure easy travel and to prevent it from dropping out of the tubing or falling into a dead space below any perforations. The crossbars may be placed several joints above the bottom of the tubing string, inasmuch as paraffin is usually deposited between the static fluid level and the top of the well, and not near the bottom. The scraper is placed in the lubricator after the above precautions have been taken. The bull plug with the spring or rubber cushion is made up, the regular producing connections are closed, and the tubing head master gate is opened to permit the scraper to drop to the crossbars in the tubing. The rate of all will depend on the clearance between the scraper fins and the tubing as well as on the viscosity of the fluid in the column and the relative weight of the scraper. After enough time has elapsed to allow the scraper to reach bottom, the bypass gate is opened and the well flowed at a rate sufficient to return the scraper to the lubricator. The downward and upward travel of the scraper tends to cut any paraffin film and cleans the inside walls



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NOTES:

1. **Any kind of metal or alloy may be used in casting and making this paraffin scraper.**
2. **For use in any size tubing, the largest diameter of the scraper shall be an average of the I.D. and drift diameter of the tubing. tubing.**
3. **Any desired thickness of the fins may be used.**
4. **On scrapers made for 2-in. tubing, ⅝-in. rods will be used. However, the fishing neck will be upset to 6/8 in.**

of the tubing. If the trial run indicated a full drop of the scraper to the cross-bars, the device may be left in the lubricator until the well is again shut in, and the operation repeated. If the scraper returned to the lubricator in a very short time after opening the bypass gate, a full drop was probably not obtained, and the scraper should be dropped and flowed up again until a satisfactory run is achieved.

● **Scraper should be run frequently.** Effective use of the device depends on its travelling the full length of the tubing initially and at frequent intervals to prevent formation of a hard paraffin coating on the inside walls of the tubing.

One of the operators using the scraper in the West Edmond field reports satisfactory elimination of paraffin trouble by running it regularly twice a week. One run per week might be adequate, but two runs per week provide easier downward travel and a wider margin of safety against the danger of getting the scraper stuck on the return trip when the well pressure becomes weak.

● **Limitations and observations.** The automatic scraper is not adaptable to a well equipped with tubing of various inside diameters, nor, generally, to wells with low flowing pressures. It is very useful, however, in wells equipped with one of the usual sizes of tubing so long as the well pressure is sufficient to flow it to the surface, and so long as it is run frequently enough to keep the tubing clean enough to permit it to drop to the cross-bars.

The automatic scraper is not new. It was discussed in a paper on paraffin problems written in 1935, and many operators have experimented with it. For one reason or another, some operators discarded its use in favor of mechanical scraping. Interest in the scraper has been maintained by some of the larger operators, however, and its use seems to be increasing on account of the reported savings in manpower and expense.

● **Ways of recovering stuck scrapers.** Sometimes paraffin deposition is more rapid in one well than in others in the same field. This may be due to differences in rates of production, gas-oil ratios, water-oil ratios, flowing pressures, or the position of the static fluid levels. Whatever the reason, the more rapid deposition may be sufficient to cause the scraper to stick at some point in the tubing, and the pressure of the well may be insufficient to flow it out.

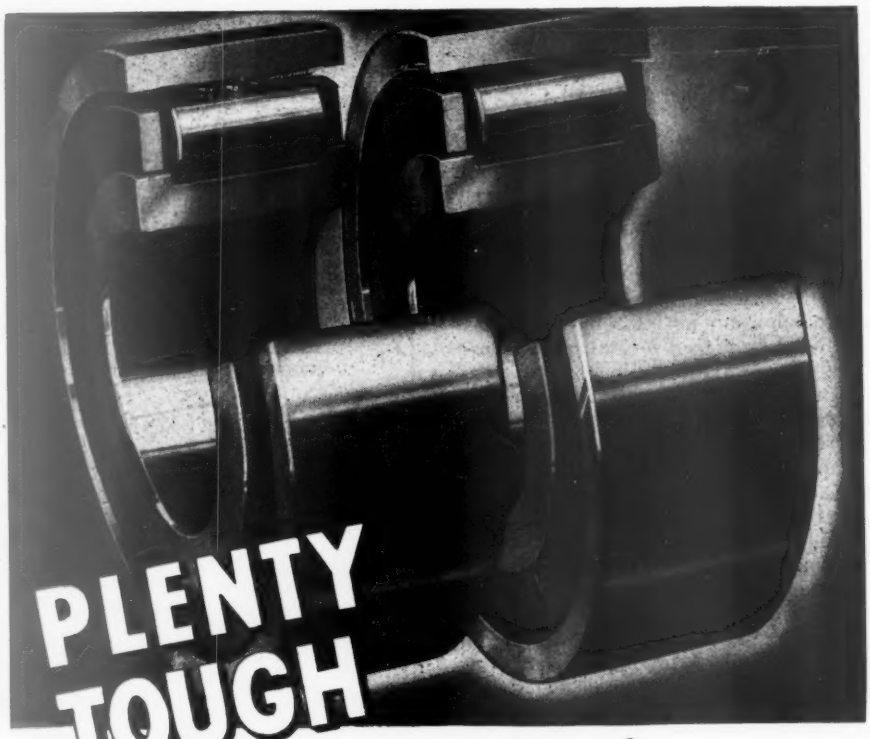
The most positive way to recover the scraper is to fish for it with a slip-type socket. This may be run with a set of jars on a measuring line operated from a portable hoisting unit.

Sometimes, however, high pressure gas from the casinghead or a portable compressor may be injected into the tubing in sufficient quantity to force the scraper down. Then the well pressure might be strong enough to kick the scraper to the surface after the pressure is released from the tubing. Another way of loosening a stuck scraper is to pump oil into the tubing. This likewise tends to force the scraper down from the point where it became stuck. Then, if the well pressure is insufficient to flow it back to the surface against the increased load, the tubing may be swabbed to start the well flowing. In general, the scraper will work satisfactorily as long as a well will begin to flow naturally after it has been shut in for an hour or two, and so long as the scraper is run an ample and regular number of times per month to prevent excessively thick films of paraffin from accumulating at any point in the tubing.

The automatic paraffin scraper will not serve satisfactorily in wells that are too weak to kick off easily under their own natural pressure, nor in wells that are not kept clean by regular operation of the scraper. No difficulties have been reported so far in West Edmond from any of these potential sources of trouble. ★★★

Synthetic rubber needs

A million long tons of synthetic rubber will be required for this year, and 1,200,000 tons for 1946, S. T. Crossland, executive vice president of the Rubber Reserve Company, has told the industry. This is 124 per cent of the rated capacity of the plants for 1945 and 145 per cent for 1946.



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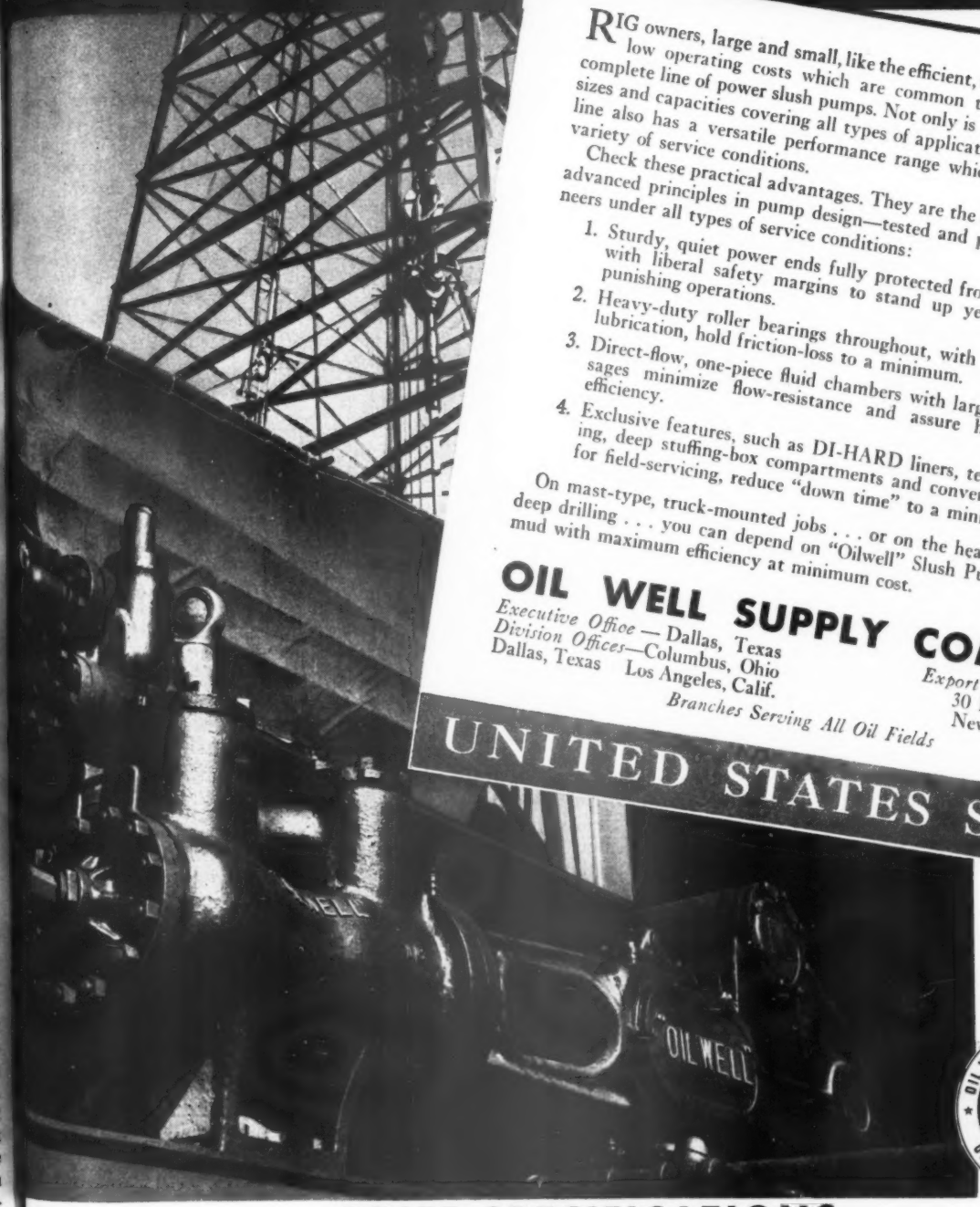

RIG owners, large and small, like the efficient, trouble-free performance and low operating costs which are common to all models in "Oilwell's" complete line of power slush pumps. Not only is there a wide range of pump sizes and capacities covering all types of applications, but each model in the line also has a versatile performance range which makes it suitable for a variety of service conditions.

Check these practical advantages. They are the direct result of "Oilwell's" advanced principles in pump design—tested and proven by "Oilwell" engineers under all types of service conditions:

1. Sturdy, quiet power ends fully protected from mud are designed with liberal safety margins to stand up year after year under punishing operations.
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3. Direct-flow, one-piece fluid chambers with large streamlined passages minimize flow-resistance and assure highest volumetric efficiency.
4. Exclusive features, such as DI-HARD liners, tell-tale liner packing, deep stuffing-box compartments and convenient accessibility for field-servicing, reduce "down time" to a minimum.

On mast-type, truck-mounted jobs . . . or on the heaviest power rigs for deep drilling . . . you can depend on "Oilwell" Slush Pumps to deliver the mud with maximum efficiency at minimum cost.

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UNITED STATES STEEL

BRIEF SPECIFICATIONS

Pump Model	Maximum Liner Size and Stroke (Inches)	Hydrostatic Test Pressure —Discharge (P.S.I.)	Maximum Fluid-Chamber Working Pressure (P.S.I.)	Max. Working Pressure with Full-size Liners (P.S.I.)	Maximum Recommended Speed (R.P.M.)	Theoretical Displacement at Maximum R.P.M. (G.P.M.)	Maximum Brake Horsepower Input At Maximum R.P.M. (H.P.)	Weight with Short Steel Skids Domestic (Pounds)
8-P	5 x 8	3,000	1,800	540	80	205	76	5,175
12-P	5 x 12	2,000	1,200	540	70	270	100	7,500
12P-LD	6 x 12	2,000	1,200	365	70	395	100	7,895
612-P	6 x 12	3,000	1,800	520	70	390	140	10,290
712-P	7 x 12	3,000	2,000	600	70	540	220	16,900
14P-HD	7¼ x 14	4,000	2,500	765	65	620	325	23,600
18-P	7¼ x 18	6,000	3,000	765	55	675	353	28,700
20-P	7¾ x 20	6,000	3,000	825	55	850	480	43,550

"OILWELL"

HEAT EXCHANGER DESIGN FOR MODERN REFINERY PROCESSING

By **S. KOPP***, *Alco Products Division*
American Locomotive Company

EXCLUSIVE Most processes involving a change of state, separation of constituents, or purification of product require the use of heat exchange equipment to some extent. Aside from the requirement of the process, economic considerations justify the use of heat exchangers. In some instances, the maximum use of heat exchange equipment is necessary to justify installation of a process plant.

S. Kopp

The petroleum industry, as one of the largest users of heat exchangers, has had a marked influence upon the design of this equipment. Paralleling the growth of the petroleum industry has been the organization and growth of numerous companies that specialize in the design and manufacture of heat exchange equipment. The leading manufacturers of heat exchange equipment have spent considerable time and money on research and development of efficient equipment from both the thermal performance and mechanical design standpoint.

The steadily increasing use of heat exchange equipment during recent years has been helped by the extensive investigations on heat transfer data by individual manufacturers, various institutions of learning, and technical societies such as ACS, AICE and ASME. Within the last few years, the heat transfer section of the ASME has been very active and has sponsored discussions at all its regional and annual meetings on this subject. This group is well organized and has a long range program for the future that covers all phases of heat transfer.

● **Codes and mechanical standards.** The colleges, universities, and technical societies have concerned themselves primarily with the development and correlation of heat transfer data for establishing size and performance of equipment. The mechanical design of heat exchangers had not been the subject of organized group study until very recent years. The early pipe coil coolers and condensers were generally assembled by the refiner. When shell and tube exchangers were introduced, the refiner generally relied upon the manufacturer to provide satisfactory equipment, subject to requirements of any local government boards. Refiners desiring to control the design of the equipment, specified the ASME Code or else prepared their own specification. With the advent of the API-ASME Code many refiners and exchanger manufacturers used it. Neither the ASME nor the API-ASME Code, however, covered the design of heat exchange equipment completely. As a result, some of the large users of equipment prepared specifications of their own based upon the API-ASME Code, adding such information as they felt necessary to cover points of design not included in this code. In some instances this resulted in a complete rewriting of the API-ASME Code to suit requirement of heat exchanger design. In 1937, the Tubular Exchanger Section of the Heat Exchange Institute published design standards specifically covering mechanical design of heat exchangers. This was followed in 1941 by more comprehensive heat exchanger design standards published by the Tubular Exchanger Manufacturers Association.

The standards of the Tubular Exchanger Manufacturers Association were issued at a time when the defense program was gaining momentum and, as a result, they were accepted by many refiners and manufacturers. The refiners substituted them for their own specifications and this permitted the manufacturer to expedite the handling of orders through his engineering office and manufacturing plants. When heat exchangers became a critical item, the War Production Board prepared a set of specifications based on the TEMA standards. The WPB specifications relaxed some of the TEMA requirements to reduce consumption of critical materials by limiting thickness of parts, increasing allowable stresses to agree with the ASME and API-ASME national emergency rules and requiring substitute materials. Although the WPB specifications were not mandatory, they were used by manufacturers for exchangers built during the time that exchangers were a critical item. These units, although of slightly inferior quality than units built to TEMA Standards, have given satisfactory service. As raw material requirements for the war are reduced, the trend is to supply exchangers in strict accord with TEMA Standards. Although some refiners are now sending their own specifications to exchanger manufacturers when requesting quotations, an increasing number are specifying TEMA Standard or using the TEMA Standards as the basis of their own specifications. These refiners' specifications are then generally limited to rules covering preferred tube sizes, tube wall gages, tube length, maximum tube bundle size, and tube arrangement. Other rules may cover inspection and test of the exchanger during manufacture, special stress relieving or X-ray requirements, special nozzles for relief valves, liquid level control, gage glass or oversize drain and vent connections, and minimum requirements for design temperatures greater than 650°F.

It is common practice for refiners to require a corrosion allowance on all major parts. As a general rule, all steel pressure parts are required to have a minimum of ⅛-in. corrosion allowance. For parts made of alloys or non-ferrous materials, corrosion allowance may be specified as added precaution, or if required for the material flowing through the exchanger. Often the selection of corrosion-resistant material will be decided on the basis of lowest first cost and expected life of equipment, rather than for maximum resistance to corrosion on a particular unit.

Full corrosion allowance is generally not specified for support plates, baffles, tie rods, or spacers. For exchangers having ⅛-in. corrosion allowance or less on

TABLE 1
Maximum gage tubes that can be rolled satisfactorily.

	Tube diameter, in.			
	¾	¾	1	1¼
Steel	11	10	9	7
Admiralty	12	11	10	8

TABLE 2
Exchanger type classification.

	Shell and multi-tube			Double pipe	Open sections
	Fixed tube sheet	Floating head	U-bend		
Bare tube	x	x	x	x	x
Longitudinal fintube	x	x	x	x	
Cross fintube	x	x	x		x
Radiator type core	x				x

*S. Kopp has been engaged in the design, manufacture, and use of heat exchange equipment for more than 20 years. Since 1928 he has been employed in the Alco Products Division of American Locomotive Company in various engineering capacities and is at present chief rating engineer. He received his engineering education at New York University and is a member of the American Society of Mechanical Engineers. He has served as a member of several standardization committees of the Heat Exchanger Institute. At present he is on the Standardization Committee of the Bleeder-Heater Manufacturers Association and is chairman of the Sub-committee on Thermal Design Tubular Exchanger Manufacturers Association.

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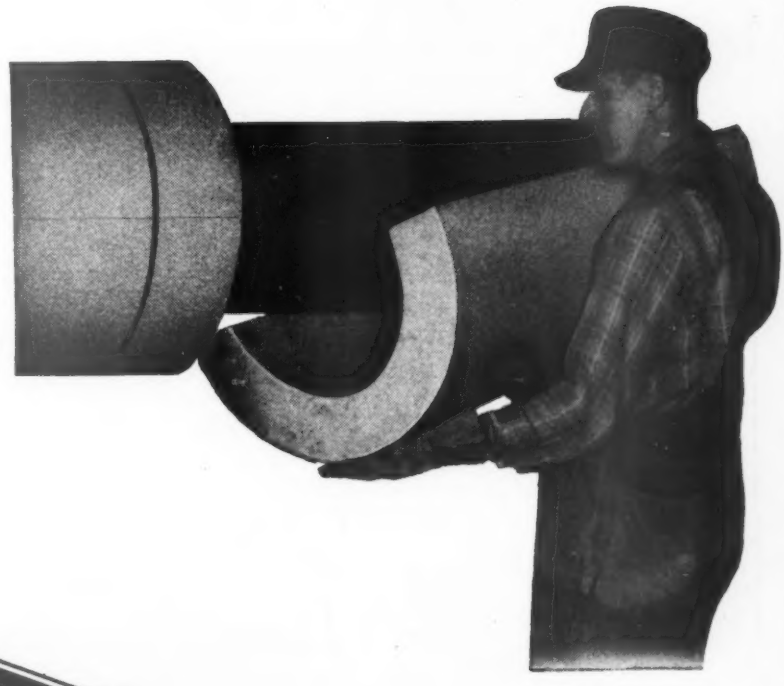
Unibestos is available in half-section form up to 30" pipe diameter and in quarter sections from 32" to 60", in thicknesses from ¾" to 5". Single layer construction is available for service up to 1200°.



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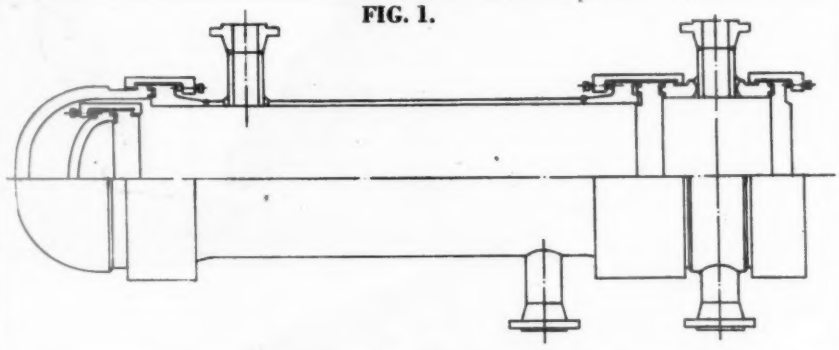
pressure parts, the minimum thickness for these parts recommended by TEMA should be used. If greater corrosion allowance is required, the thickness of these parts should be increased to permit at least one retubing of the tube bundle with the original parts.

Full corrosion allowance on tubes is not practicable in most cases. As a general rule, tubes having a wall thickness heavier than that shown in Table 1 cannot be rolled satisfactorily with any assurance of a tight joint between tube and tube sheet. Seal welding or brazing may be used to assure a tight joint with the roll used only for strength; however this may require wider spacing of tubes with resulting increase in the size of equipment. It also complicates the retubing of the tube bundle.

Large users of heat exchange equipment are becoming increasingly aware of the necessity of standardizing of certain features of design in order to obtain maximum utility from the equipment. With the rapid technological advance in refining processes and the increasing trend towards a petro-chemical industry, this is becoming more evident each day. A process plant installed for a particular operation may be obsolete before the normal life of the equipment has expired. Unless some thought has been exercised in the purchase of heat exchangers they may not be suitable for another plant without expensive alteration. Because of this, many refiners are purchasing heat exchangers to a standard that will meet the following minimum requirements:

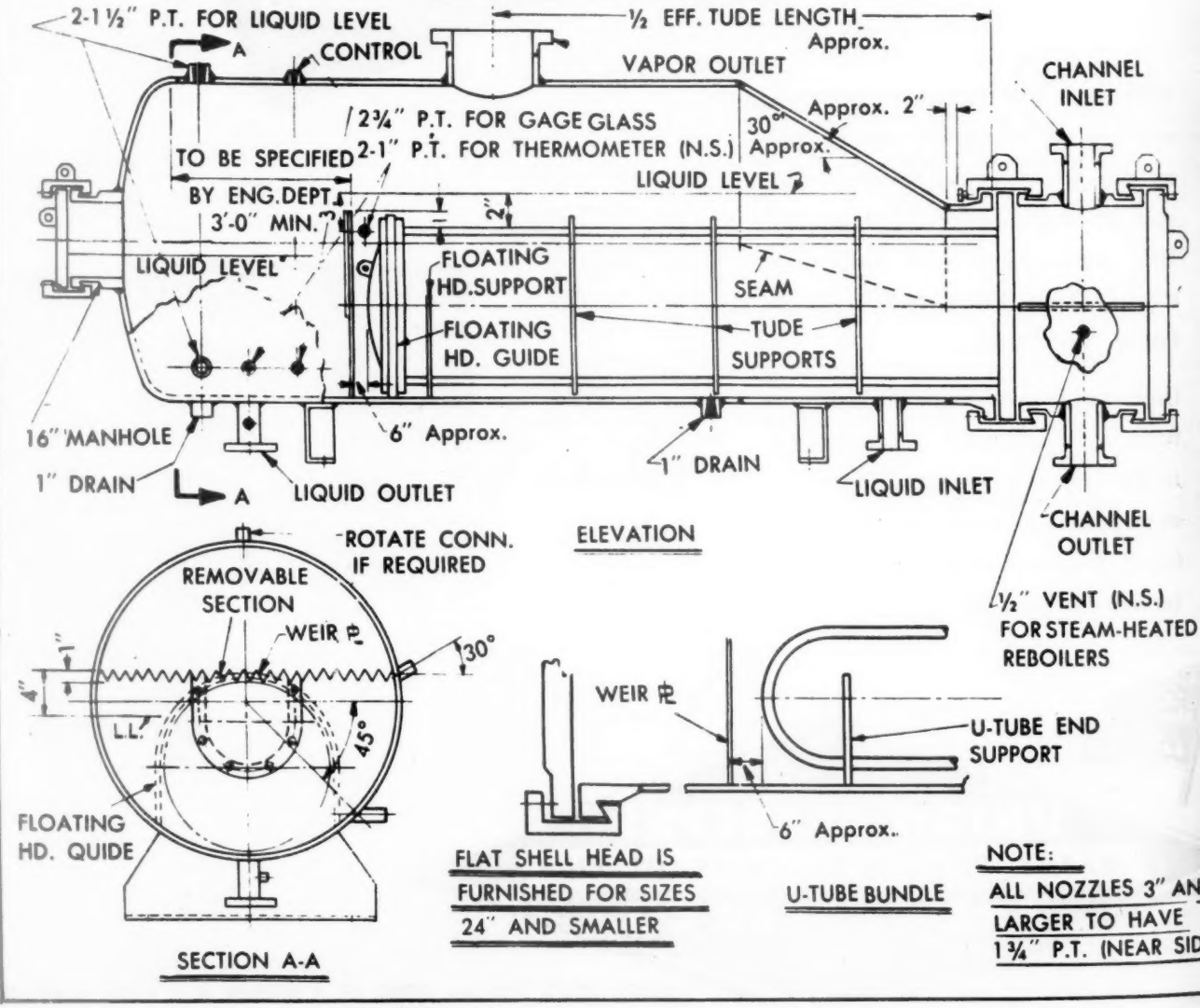
1. Maximum interchangeability of service or operation.
2. Maximum cleanability.
3. Maximum use of spare bundles.
4. Standardized pressure classifications.
5. Standardized tube size, gage, and length.
6. Maximum bundle size.
7. Minimum maintenance requirements.

FIG. 1.



● **Maintenance.** Maintenance of heat exchangers is becoming increasingly important and has influenced heat exchanger design in various ways. The present day heat exchanger, designed to well-thought-out standards, is a rugged piece of equipment that will have a long life when properly operated and maintained. The designer can incorporate various features in a heat exchanger that will enable it to "take it" in an emergency, but no exchanger will justify its cost if it is

FIG. 2. KETTLE TYPE REBOILER



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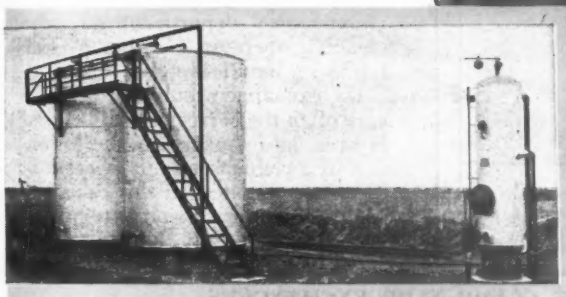
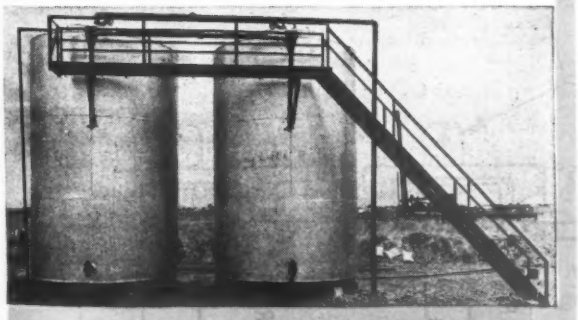
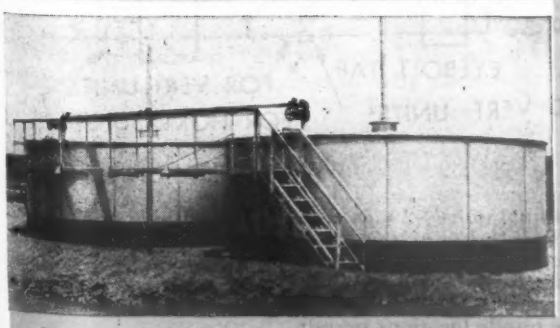
Above: Two 1000 bbl. Climax double stave, steel tanks and 4′ x 12′ x 250 lb. w.p. Climax oil and gas separator.



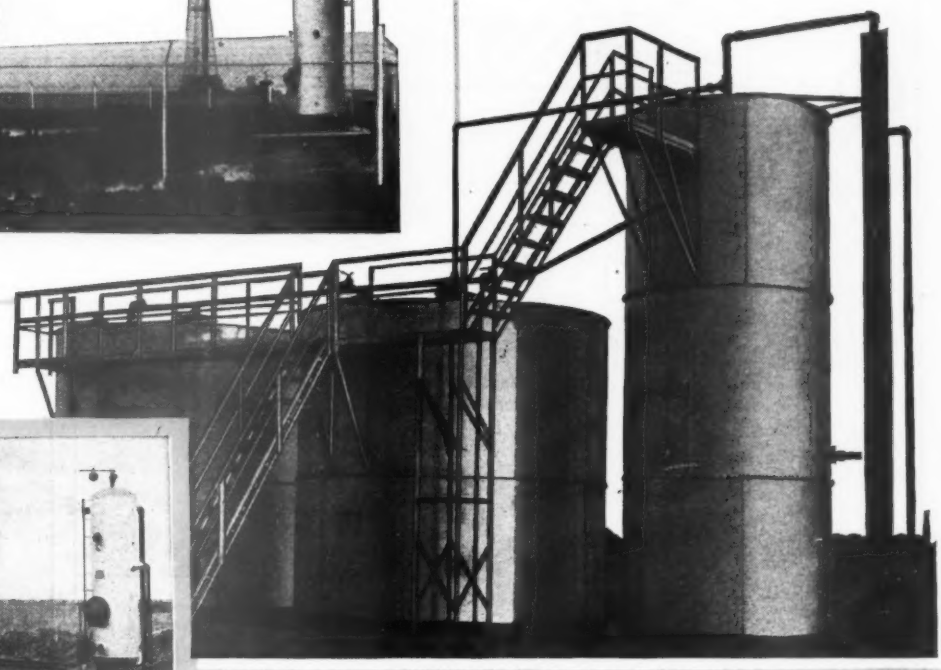
Two 150 bbl. Climax welded steel tanks with 9′ x 6″ diameter steel foundation rings. 30″ x 10′ Climax separator.



Two 150 bbl. Climax welded steel tanks with steel stairway and walkway and foundation rings.



Battery of two 500 bbl. low type Climax bolted steel tanks with galvanized bolts—steel stairway and walkway.



Battery of two 500 bbl. and one 300 gun barrel Climax bolted steel tanks with extension walkway.

CLIMAX TANKS are built of extra durable materials — with extra construction-strengthening features that insure extra years of trouble-free service *under the most severe field service conditions.* For these exclusive features they are known and preferred throughout the petroleum industry. Bolted Climax Tanks are available in 14 sizes, from 100 to 10,000 bbl. capacity. Climax Welded Tanks are available from 40 bbl. to 250 bbl. and 315 bbl. on special order.

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not properly serviced and maintained. A well designed heat exchanger will meet the following minimum maintenance requirements:

1. Easy to dismantle and reassemble.
2. Minimum weight parts consistent with sound design.
3. Provision for easy lifting of heavier parts.
4. Provision for test of tube joints.
5. Properly rolled tube joints.
6. Good gasket joints.
7. Sufficient key marks or dowels to assure proper line-up.
8. Interchangeability of tube bundles of the same size.

Figs. 1 to 5 inclusive, show general design and details of a heat exchanger meeting the requirements just listed.

A well balanced maintenance program requires that statistical data be kept of costs, time off stream, condition of equipment, etc. This may be a very simple record in the small refinery or an elaborate system in a large refinery, with a definite trend by all refiners to keep rather complete records.

Several of the large refiners have established systems to record the following minimum information on all individual heat exchangers.

1. Drawings.
2. Dates of cleaning.
3. Cost and nature of repairs.
4. Rate of corrosion.
5. Replacement of parts.
6. Duplication of exchangers and bundles.

Reference to these records enables the maintenance department to schedule cleaning operaton, shifting of bundles, replacing bundles, etc.

On exchangers subject to corrosion, very often the corrosion will be localized in area, as for example, the lower portion of a condenser shell where a liquid layer accumulates. In this case, less excess metal for corrosion is required or a

FIG. 3. TEST RING ASSEMBLY
The function of the test ring is to permit the shell side test to be applied to the tube bundle when it is assembled in the shell leaving the tube ends exposed to view to determine the existence of any leaky or defective tubes.

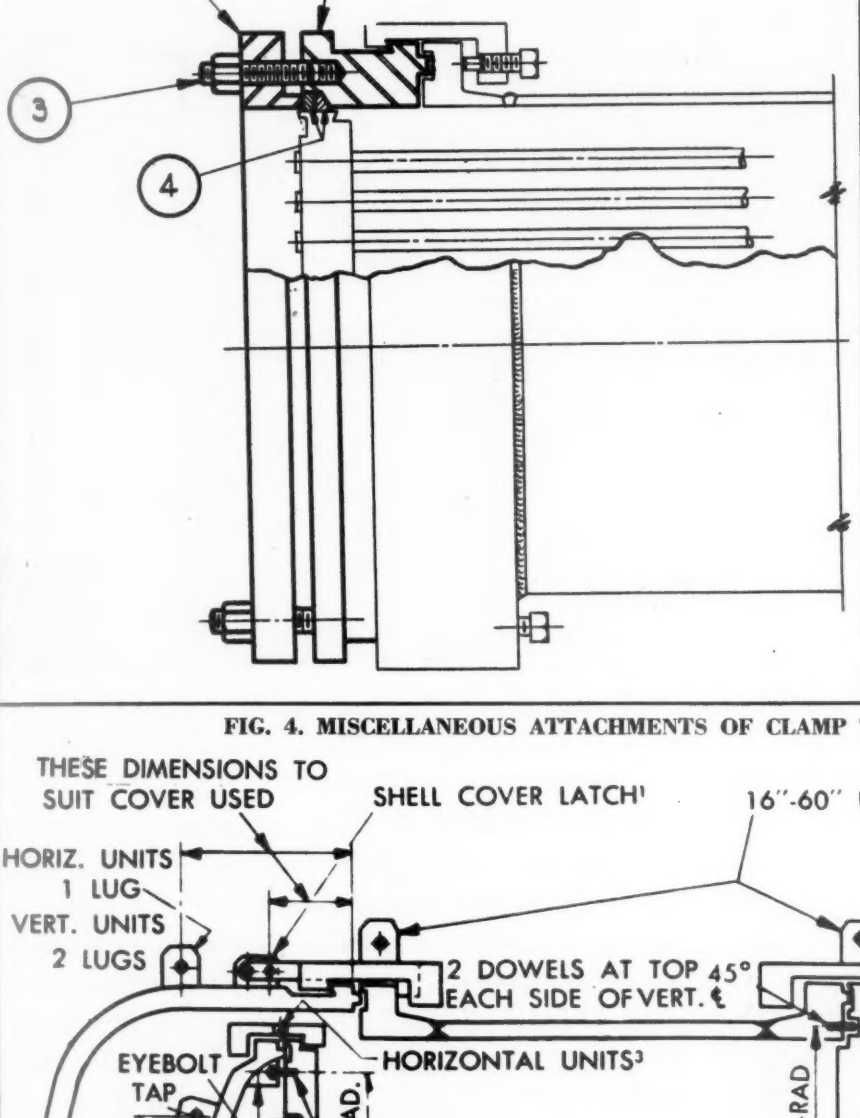
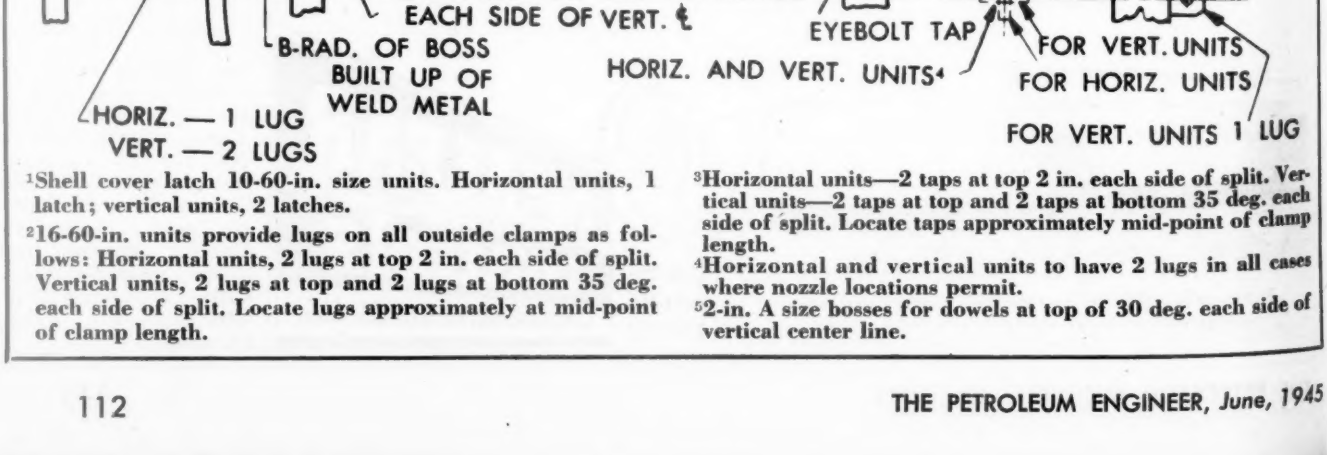


FIG. 4. MISCELLANEOUS ATTACHMENTS OF CLAMP TYPE EXCHANGERS



¹Shell cover latch 10-60-in. size units. Horizontal units, 1 latch; vertical units, 2 latches.

²16-60-in. units provide lugs on all outside clamps as follows: Horizontal units, 2 lugs at top 2 in. each side of split. Vertical units, 2 lugs at top and 2 lugs at bottom 35 deg. each side of split. Locate lugs approximately at mid-point of clamp length.

³Horizontal units—2 taps at top 2 in. each side of split. Vertical units—2 taps at top and 2 taps at bottom 35 deg. each side of split. Locate taps approximately mid-point of clamp length.

⁴Horizontal and vertical units to have 2 lugs in all cases where nozzle locations permit.

⁵2-in. A size bosses for dowels at top of 30 deg. each side of vertical center line.

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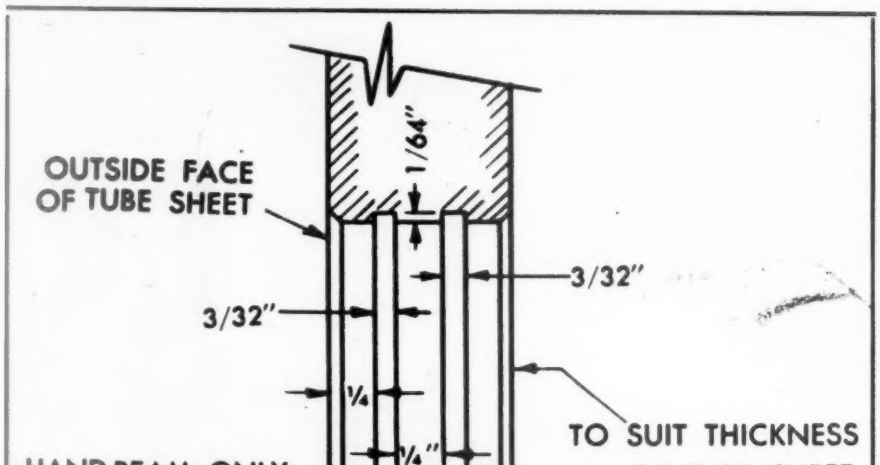


FIG. 5. TUBE HOLE GROOVING IN TUBE SHEET

for this, especially on non-ferrous tube sheets. One refiner has found that this extra metal on naval rolled brass tube sheets permits more retubing of bundles with the original tube sheet, thereby decreasing bundle replacement costs and the saving of time in rebuilding the tube bundle. At the present time, there are a number of special tools and equipment available to the refiner to facilitate dismantling and cleaning of heat exchangers. The pulling of tube bundles and handling them, however, still requires manpower. The desirability of having this work done by mechanical means is rather obvious and several devices along this line have been proposed. At this writing, however, none of these is developed to the point where it can be offered to refiners and other users of heat exchangers.

● **Design types.** The refiner purchasing heat exchange equipment at the present time has several standardized designs that can be obtained from most manufacturers of heat exchangers. These types are summarized in Table 2. In addition to the types listed there are a

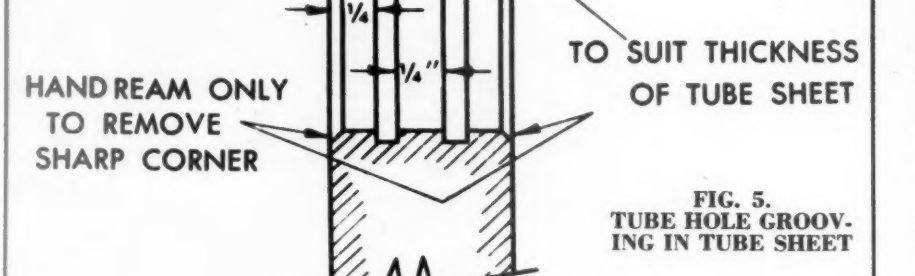


FIG. 6. FLOATING HEAD TYPES

FIG. 7. AIR COOLED HEAT EXCHANGER

longer life with a given excess thickness can be obtained by rotating the shell 180 deg. This requires that both inlet and outlet nozzles be made the same size and also requires relocating piping. The necessity of relocating piping can be eliminated by making both shell end flanges identical. This then permits the shell to be turned end for end in addition to rotating it 180 deg. A design incorporating this feature is shown in Fig. 1.

Virtually all tube bundles are made symmetrical about the horizontal centerline. This permits the bundle and channel to be rotated 180 deg., thereby often obtaining longer life where localized corrosion occurs. When duplicate bundles are in use, one subject to corrosion and the other not, it is possible to alternate the bundles between the two services and thereby prolong the usefulness of both bundles. In maintaining tube bundles, a certain amount of rerolling of tube joints due to leaks or retubing will be done. In some cases, this will bow the tube sheets slightly, thereby requiring machining of the gasket faces. Provision should be included in the original thickness to allow

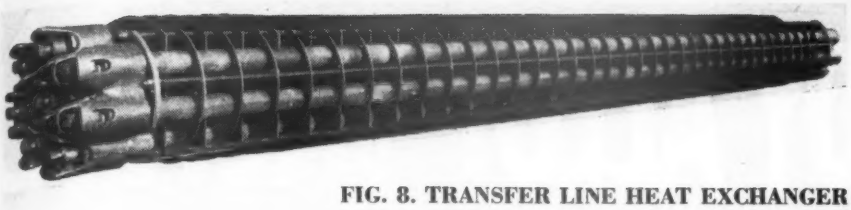


FIG. 8. TRANSFER LINE HEAT EXCHANGER

number of special designs available, some of which have been standardized to some extent.

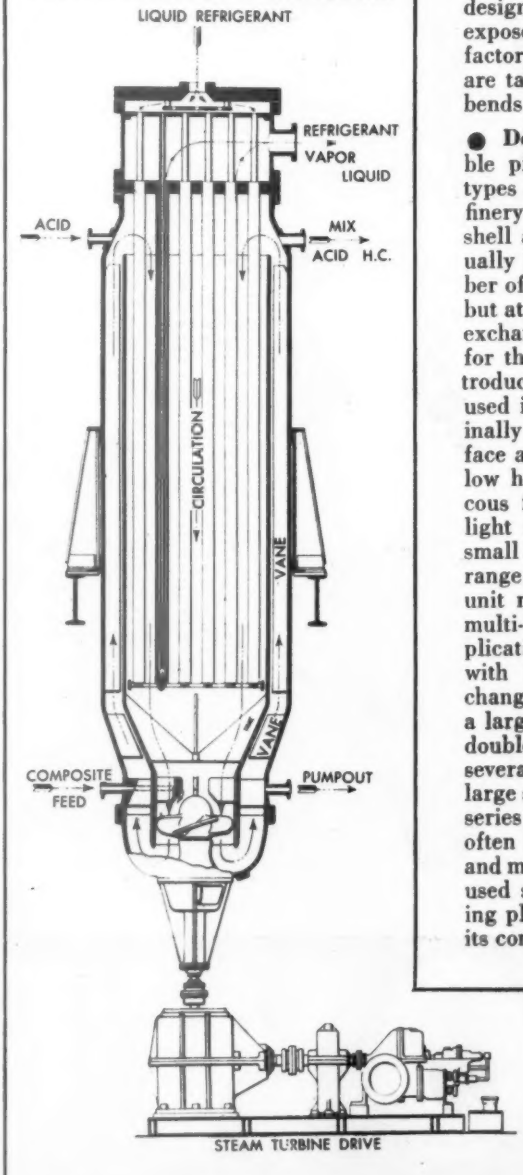
● **Shell and multi-tube designs.** The shell and multi-tube design in its various forms is the most common exchanger seen in the refinery and its continued use as a basic design is without question. It has the advantage of providing a large amount of surface in a comparatively small space. Although most of these designs have cylindrical shells, a number of rectangular shell units are in use, generally for low pressure service.

This design, using a cylindrical shell, can be built in any size within shipping limits and any pressure that may be required for present or possible future refinery processes. To meet some of the service requirements, such as high pressure, high temperature, sub-zero temperature, or excessive corrosive allowance, special designs of this basic type may be required. These will be considered under the heading of special designs.

● **Floating head design.** Most of the shell and multi-tube exchangers in service have a floating head design of some sort to take care of differential expansion between the tubes and the shell. Several designs of floating head construction are shown in Fig. 7. Floating head types 1, 2, and 9 are used generally on low pressure units, principally for oil coolers, jacket water coolers, and similar services around the refinery. Type 9 floating head was used by one refiner for a number of years exclusively but has since been replaced by types 4 and 5 floating heads. The type 9 floating head is in common use in chemical plants. As a general rule it is used for water cooled units with the water in the shell. For this service units of 48-in. shell diameter have been in successful operation for years. This design has been used in smaller diameters for pressures greater than 300 lb. in the shell side by using deep stuffingboxes. Although there may be some use for this design in the production of chemicals by refiners, the present indications from current purchasers of exchangers is to stay with the internal floating head design, using types 3 to 6, inclusive, or type 10 floating heads. Type 4 or 5 floating heads, or slight modification of this basic split ring design, are the most common designs used by manufacturers and are preferred by most refiners. These two types require the removing of the shell cover and floating head cover before the bundle can be removed. Although this involves extra labor the designs have the advantage of permitting smaller diameter shells to be used. The clearance between the outer row of tubes and the inside diameter of the shell is a minimum when using these designs as compared with exchangers using type 3, 6, or 10 floating heads. Except for a few cases, this small clearance eliminates the necessity of installing seal strips, deflector baffles, or other means to keep the fluid from bypassing the tubes.

● **Fixed tube sheet design.** The fixed tube sheet design is used to a limited extent, especially for clean nonfouling fluids operating at low temperature levels so that expansion is not a factor. Expansion joints are used to take care of moderate temperature differentials on units operating under relatively low pressures. For high pressures the expansion joint is expensive and unless special considerations require the use of fixed tube sheets, a floating head unit is preferable. For waste heat boilers or steam generators, with the hot gases or non-condensable vapors flowing through the tubes, fixed tube sheet units have proved satisfactory where the service is not subject to rapid temperature fluctuations. These units approximate fire tube boiler designs, but because the gases may be above atmospheric pressure or inflammable, special consideration must be given to the design of tube sheets, flanges, and to the method of attaching tubes to the tube sheet.

FIG. 9. STRATCO CONTACTOR.

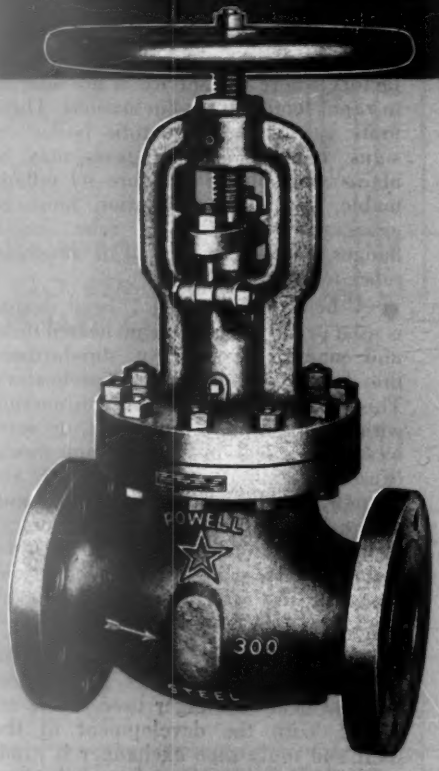


● **U-bend design.** The U-bend design is used principally for steam heated units and many refiners have standardized this design for reboilers and preheaters. This design is also used, in conjunction with a double fixed tube sheet, on services where a leak in the tube joint would cause contamination of a product. On the new HF Alkylation plants the U-bend design has been used in the exchangers exposed to the acid and has given satisfactory service when certain precautions are taken in the manufacture of the U-bends and tube bundles.

● **Double pipe design.** The basic double pipe design is one of the earliest types of heat exchanger used in the refinery. With the development of the shell and multi-tube exchanger it gradually lost favor in the refinery. A number of units are used in special services, but at the present time most double pipe exchangers have a longtitudinal fintube for the inner pipe. This design was introduced about 14 years ago and has been used in a large range of services. Originally developed to provide a large surface area on one side to compensate for low heat transfer rate obtained on viscous fluids, it has since been used on light oils in some applications. For a small stream having a large temperature range of cooling a double pipe fintube unit may be cheaper than a shell and multi-tube design. Another possible application is the case where a large stream with a small temperature range exchanges heat with a small stream having a large temperature range. In this case, double pipe fintube units arranged in several banks with parallel flow of the large stream over the fintube surface and series flow through the tube will very often be more economical than a shell and multi-tube unit. This design has been used successfully in the newer processing plants, and there seems no doubt of its continued use in these and later processes that may be developed.

● **Open sections.** The open section, placed inside a cooling tower, has been extensively used in the past in some parts of this country and abroad, especially in gasoline plants. To be most efficient, these sections must be situated in the base of the cooling

HASTELLOY ALLOY VALVES



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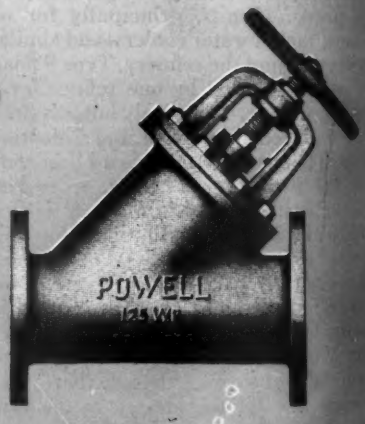

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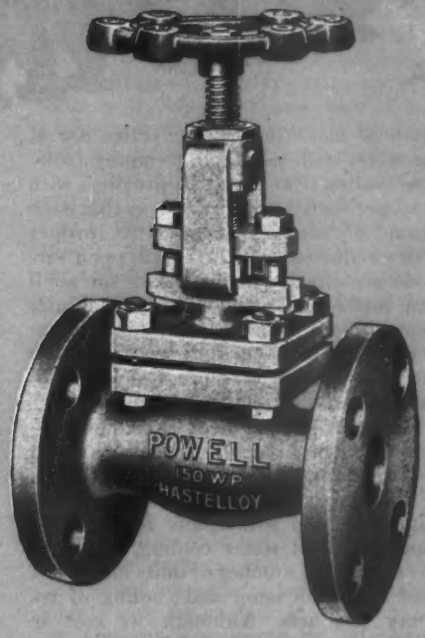

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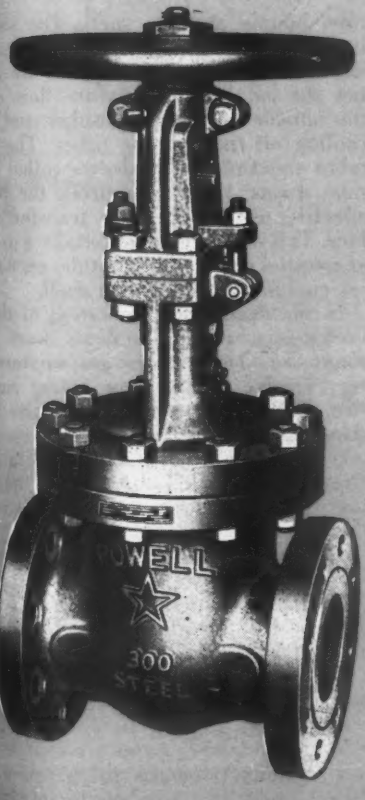
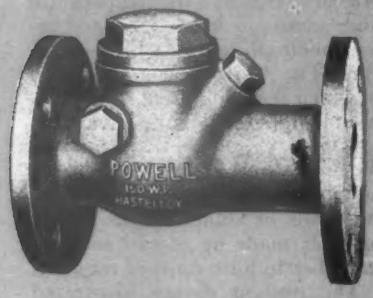
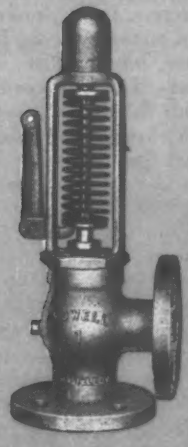


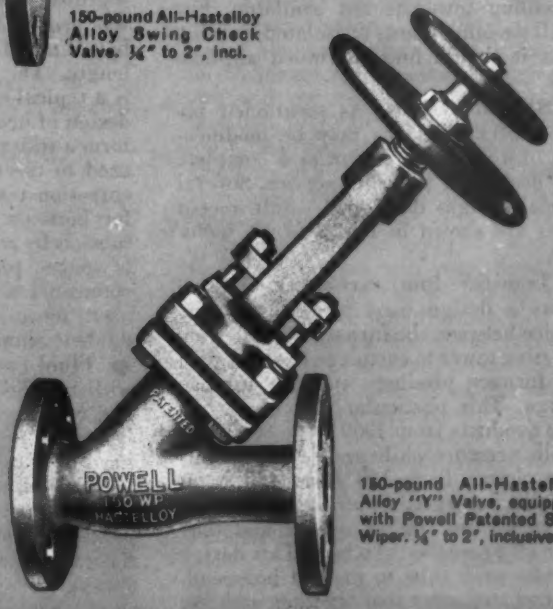
Class 300-pound Cast Carbon Steel Gate Valve with Hastelloy Alloy Trim.



150-pound All-Hastelloy Alloy Swing Check Valve. ¼" to 2", incl.



All-Hastelloy Alloy Angle Relief Valve. ¼" to 4", inclusive.



150-pound All-Hastelloy Alloy "Y" Valve, equipped with Powell Patented Seat Wiper. ¼" to 2", inclusive.

VALVES

FIG. 10A. ASSEMBLY OF TUBEFLO SECTIONS

FIG. 10B. SECTION THROUGH TUBEFLO SECTION ELEMENT

tower to make the most effective use of the water with minimum pumping costs. The cooling tower must be provided with a proper distribution system so that each group of sections receives its proper water requirements. Although open sections are cheaper in first cost, the shell and multi-tube exchanger is generally used in more recent gasoline plants. Experience with open sections has shown that they scale up more quickly than shell and multi-tube type exchangers.

An open section heat exchanger design developed recently is the air cooled heat exchanger. Fig. 7 shows one design of this exchanger now on the market. Although used principally for lube oil cooling, jacket water cooling, and similar services, a number of units have been used for condensing and cooling of refinery products. Although its cost is higher than a water-cooled heat exchanger, it can be justified economically in localities where water costs are high and a cooling tower is not available. For small gasoline plants or isolated installations it should find continued application.

● **Special designs.** As mentioned before, special designs may be modification of a standard design or a complete new design for a specific service. Several special designs developed within recent years are shown in Fig. 8 to 10, inclusive.

● **Transfer line exchanger.** Fig. 8 shows a design used for transfer line service between the furnace and the fractionating tower to exchange heat between the furnace products and the furnace charge. This particular unit cools furnace products from 1060°F. to 800°F. at 800-lb. pressure while preheating the furnace charge from 120°F. to 430°F. at 1100-lb. pressure. Several larger units are in use on similar service and they have all proved satisfactory. This design permits each tube to expand independently of any other and together with the use of rugged furnace type headers assures minimum possibility of leakage at tube joint from expansion stresses. The use of this exchanger eliminates or reduces quenching with the resultant increase of heat availability at high temperature levels.

● **Contactor-cooler unit.** Fig. 9 is a design originally developed for the cooling of hydrocarbon-acid mixtures in alkylation plants. This design combines fluid circulating and mixing with the heat exchanger. The quantities processed are very large and the temperature range very small, the heat exchanged being due principally to heat of reaction or mixing. For services comparable to that for which it is now used, this principle design offers the definite advantage of compactness.

● **Tubeflo section.** Fig. 10 is a design that has advantages for services involving dirty fluids or sludges. This design was originally made up of cast sections bolted together to form units of required length. The present design illustrated is a typical example of improvements in design of heat exchangers. In its present form a wider range of metallurgy can be used to meet pressure, temperature, or corrosion requirements. The heat transfer between the fluids in the separate tubes is by conduction through the closely spaced plates. Each pair of tubes is connected to separate headers or crossover pieces, hence contamination of fluids is eliminated.

● **Fluid catalyst cooler.** In connection with the fluid catalytist process, a special exchanger is used to cool the catalyst after regeneration. Several designs have been developed for this service depending on whether they are oil cooled or used to generate steam. With the exception of one installation, these designs have the catalyst and carrier gas flowing through the tubes and the oil or water in the shell, both in a single pass. Because of the large nozzles required for the flow of the catalyst-gas mixture and also the high temperatures involved, stuffingboxes are not used. Instead either an internal expansion joint situated between the floating head cover and the shell cover, or an external expansion joint, forming part of the shell, is used. This expansion joint is of the accordion type to take care of the large temperature differential existing between the tube bundle and the shell. The single installation differing from this design eliminates the expansion joint by having the catalyst-gas mixture flow over the outside of U-bend fintubes and the cooling oil through the tubes. The fintubes are enclosed by sleeves rolled into tube sheets, thereby assuring the most effective use of the heat transfer surface. This design is substantially a group of parallel double pipe fintube exchangers enclosed in a common shell.

In the design and operation of these exchangers, many problems were encountered. The catalyst-gas mixture is very erosive and to some extent corrosive. Experience with these units has shown that special precaution must be taken to assure satisfactory operation. Experience to date indicates that the following factors assure satisfactory operation:

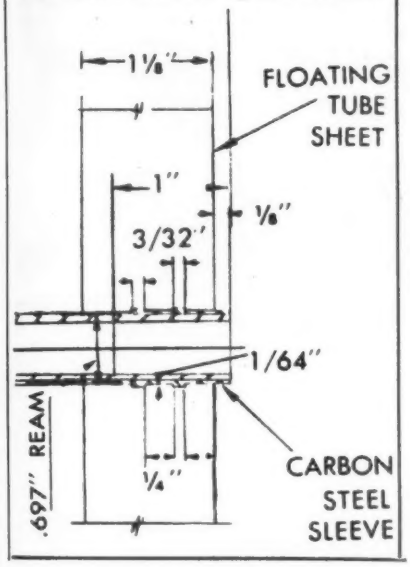
1. Uniform flow distribution of catalyst-gas mixture over all tubes.
2. On up-flow units a minimum velocity must be maintained to assure flow of catalyst by the carrier gas.
3. Velocities should be kept down to minimize erosion.
4. Carbon steel is satisfactory provided metal temperatures are kept down.
5. Sudden changes in direction of flow should be avoided to minimize change in composition of catalyst-gas mixture due to stratification.

● **Low temperature service exchangers.** Heat exchangers to be used for sub-zero temperature service can be manufactured either in standard or special designs provided proper materials are used for the temperatures required by the process. For temperatures to minus 20°F., low carbon steels are satisfactory. For temperatures between minus 20°F. and minus 50°F. good grade killed low carbon steel that will

meet charpy impact tests is satisfactory. For temperatures between minus 50°F. and minus 75°F., 2½ per cent nickel steels give satisfactory service. For temperatures between minus 75°F. and minus 150°F., 3½ per cent nickel steels and cupro-nickel are recommended. Below minus 150°F. monel, nickel, copper, and some copper alloys should be used.

In addition to the materials listed there are others that may be used provided they are satisfactory to use with the fluids being processed. Among these aluminum and magnesium alloys are being considered for special designs of heat exchangers to operate at temperatures to minus 300°F. This process requires a large amount of surface to operate at very low temperatures, and special designs of a type not now in use in oil refineries are being developed to provide heat transfer surface requiring minimum weight and space. The designs now being developed have about one-fourth the weight and space requirements and it is estimated that they will cost about a third as much as conventional heat exchangers. Some of the designs studied to date in connection with this development suggest their possible use for light oil and petro-chemical processes now in use.

FIG. 11. A METHOD OF INSTALLING BI-METALLIC TUBES



● **High temperature service exchangers.** Heat exchangers operating at a temperature greater than 650°F. are considered high temperature exchangers by most refiners and consideration to the use of appropriate materials is necessary in their design. For temperatures up to 1000°F., low carbon steel has given satisfactory service provided operating pressures are not excessive. Carbon moly steel is also used in this range, especially if operating pressures exceed 300 lb. per sq. in. For temperatures greater than 1000°F., materials ranging from low chrome steels to high chrome nickel alloys are used as are also monel and nickel. The choice of the material to be used may also be influenced by its corrosion resistance at the higher temperatures and also its adaptability in fabricating the component parts of the exchanger.

Heat exchangers operating at high temperatures and high pressures, or ones that are of large shell diameter, may require special analysis of stresses to assure a satisfactory design. When the temperature gradient across a component part is high, the stress resulting from this temperature differential may exceed the stress due to the pressure alone. If this condition exists the designer must resort to insulating the part, reinforcing it in some way or reducing its size.

If temperature differential produces excessive stress in the tubes, this can be reduced by using multiple floating heads or increasing the number of shells operated in series. Multiple floating heads increase the cost of the exchanger, often costing more than two or more single floating head exchangers.

● **Extended surface exchangers.** Extended surface exchangers, commonly called fintube exchangers, are available in a number of standard and special designs. At the present time several designs of extended surface tubes are available to the designer and user of heat exchangers. Some of these are in use for general refinery heat exchangers, but the others have been used only for special exchangers. For example the special fintube with the fin attached to the tube at an angle is used in the thermofor kiln installed in bead catalyst units.

Several types of tubes having internal fins have been developed for use by other industries. These are made of nonferrous materials and the writer knows of no case where they have been used in refinery heat exchangers. Continued development work in both internal and external extended surface tubes is being done by several manufacturers at this time. The extended surface heat exchanger designs in use by refineries have given satisfactory service and their continued use on present and later process plants is to be expected.

● **Designs for corrosion resistance.** When corrosion is a factor in the design of a heat exchanger a large variety of materials are available, and new ones are being developed continuously. The use of alloys and other special materials in exchanger construction is increasing and will continue, especially for units installed in refineries producing chemicals. At the present time heat exchangers are in service having component parts made of such materials as plastics, glass, rubber, and carbon. In using some of these materials, manufacturing techniques will vary, depending upon the part of the exchanger being made from these materials.

The use of bi-metals has increased over a period of several years. These are used to lower the cost of exchangers by using corrosion-resistant material on the side handling the corrosive fluid. The corrosion-resistant metal is applied by bonding during its manufacture or during fabrication of the heat exchanger. In installing bi-metallic tubes into tube sheets precaution must be taken to have the end so designed that only metal suitable for the fluid in contact with it is exposed. Fig. 11 shows one method of properly installing bi-metallic tubes in tube sheets.

Fig. 12 shows a section of U-bend made from a bi-metallic tube that was annealed after bending. This annealing is for the purpose of relieving bending stresses that accelerate corrosion when exposed to acids. Although both metals have thinned down at the outer radius of the bend, no separation of the two metals has occurred. ★ ★ ★

FIG. 12. BI-METALLIC TUBE AFTER BENDING AND ANNEALING

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SALT WATER DISPOSAL IN EAST TEXAS

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INSTALLMENT NO. 9

EXCLUSIVE ● **Chemistry of treating salt water for subsurface disposal.** In discussing salt water it should be kept in mind that we are not thinking of pure water at all but a complex solution of a mixture of various salts. The properties of this solution depend not only upon the character of the salt water originally trapped in the formation but also upon the history of the salt waters following entrapment. These properties are closely associated with the temperature, pressure, and character of the formation. The salt waters found associated with oil vary from practically fresh water to solutions containing as much as 35 per cent, by weight, of dissolved salts. This discussion will be limited to the character and properties of the salt water produced in the East Texas field.

The analysis of salt waters produced from the East Texas field indicates the following composition:

Sodium	22,000 to 25,000 ppm.
Calcium	1,300 to 1,500 ppm.
Magnesium	170 to 220 ppm.
Iron	12 to 18 ppm.
Chlorides	34,000 to 43,000 ppm.
Bicarbonates	500 to 900 ppm.
Sulphates	200 to 400 ppm.
Total solids	70,000 ppm.
pH	7.1 to 7.2

The above data are intended to illustrate a typical East Texas salt water and perhaps do not cover all cases. Such analysis, however, should represent an average salt water reasonably closely.

It will be noticed that this composition represents approximately two times the concentration of salts in present day sea water. No speculation will be made here as to whether the ancient sea, into which the sand of the East Texas reservoir was deposited, was more concentrated in salts than the present seas or whether concentration occurred after the deposition had taken place.

In discussing the chemistry of salt waters, it is also advisable that we keep in mind not only the actual chemical reactions but also the physical forces that make up an important phase of the treatment and the reactions. The physical chemical phase of treating salt water for subsurface disposal has an important bearing upon the design of the plant and system for handling the salt water. This relationship will be discussed as the full treatment of the salt water is developed.

In present day practice there are two important types of systems commonly used in treating salt water for subsurface disposal; namely, the closed system and the open system. Modifications of these systems to include what are called semi-closed and semi-open systems have been made, but the discussion will be confined to the two primary types.

● **Closed system.** The closed system will be discussed first, not because it is most widely used or because it might have greater merit, but because the theory is simpler and the chemistry is less complex.

In theory the closed system prohibits the admixing of air with the salt water, thus preventing the oxidation of the iron. The absence of the above reaction eliminates the formation of a floc in the water and makes unnecessary the use of coagulants and filters in the system. The absence of oxygen from the air leaves the salt water in a relatively noncorrosive state and makes it possible to use unlined, or bare iron, tubing and fittings.

In practice, however, as with so many theoretical conditions, such behavior is not always followed.

Due to the presence of rather large quantities of bicarbonates in the salt water, there are very important reactions that occur from reduction of pressure alone. At the pH value of the East Texas salt water all the carbonates exist as bicarbonates and, more specifically, the iron and calcium as their respective bicarbonates. Iron and calcium bicarbonates are unstable compounds and owe their existence to a high partial pressure of carbon dioxide. The following reactions illustrate this:

$$Ca(HCO_3)_2 \gtrless CaCO_3 + H_2CO_3$$
$$\gtrless$$
$$H_2O + CO_2$$
$$\gtrless$$
$$Fe(HCO_3)_2 \gtrless FeCO_3 + H_2CO_3$$

It may be seen that with a solution containing calcium or iron carbonate in water with carbon dioxide that if the pressure is increased, the equilibrium will be shifted toward the formation of the bicarbonate causing the iron or calcium bicarbonate to go into solution. Conversely, if the pressure on a solution of iron or calcium bicarbonate be reduced, the equilibrium will be shifted to the right, resulting in the formation of the carbonates, which precipitate, and in the liberation of carbon dioxide.

The chemistry of treating salt water for subsurface disposal. A discussion of the open and closed systems.

As the salt waters are produced the pressure is released and in a closed type system there are formed solid precipitates of iron and calcium carbonates. These compounds can be shown to be present in the waters of a closed system by a survey of the iron content at various points in the system. The decrease in iron content is most noticeable at the hay-tank, which acts partially as a filter to remove the solids from the water.

The closed system is ideally suited as a media for the culture of certain types of bacteria. The most troublesome bacteria that may be encountered are the "vibrio desulfuricans," an anerobic bacterium that derives its energy by the reduction of the sulphates that are present in the salt water. Such reduction results in the formation of hydrogen sulphide, a gas that has the odor of rotten eggs, and is soluble in water. Hydrogen sulphide is an acidic gas that is capable of attacking iron, causing the formation of iron sulphide, a black solid, resulting in corrosion of the equipment and solids in the water.

As these bacteria are anaerobic, the most common way to combat them is to raise the oxidation potential of the water. Normally this is accomplished with chlorine gas. In a closed system, however, such a treatment would result in the oxidation of the ferrous iron to the far less soluble ferric iron, causing the formation of a troublesome solid in the water. The increased oxidizing potential would also increase the corrosiveness of the salt water, destroying the advantage of being able to use unlined equipment and tubing strings.

Thus it may be seen that through rather simple chemical reactions there are solids formed in the waters of a closed system. These reactions are a result of the mechanics of oil production, the fundamentals of which may not be changed. Likewise, the control of bacterial contamination requires the use of a germicide that is poisonous to the bacteria in order to prevent increasing the oxidation potential. Similarly, it is advisable to include filtration in any closed system in order to remove the solids resulting from the above reactions.

● **Open system.** The open, or aerated, type system is more complex than the closed type. The discussion of the chemistry of this kind of treatment will be developed step-wise in the same sequence as the water passes through the system.

Skimming. Salt water as usually gathered directly from the gun-barrels of various tank batteries always contains some oil. Actually the oil is present in the water in two different physical conditions. In one form the oil occurs in bulk and as such promptly floats to the

surface and may be removed by means of a series of baffles. Oil in such condition is troublesome and presents problems, from the chemical point of view, in the treating of salt water for injection.

Oil also occurs in the salt water as gathered into the treating system in a second state, which is of interest in a physical-chemical sense. Such oil is a finely divided suspension that, under the existing conditions, is perfectly stable and will not separate. This finely divided oil suspension is of the oil-in-water type and, as such, loses the properties of the oil and appears to be like water. Such water-like properties arise from the fact that each small oil droplet has a film of water tightly bound to its surface. This film of water, due to the electrostatic forces that hold it, is in a highly compressed state and does not have the properties usually associated with water. There is, however, a gradual transition to the ordinary kind of water as the distance from the particle of oil increases. This transition of properties causes the particle to behave as if it were water, with the result that removal by settling will not take place. Oil occurring in the water in such condition must be removed by chemical means, as will be explained later.

First, let us examine the result of the bulk of the oil on the skimming operation and upon future steps in treating the water. The most common way of removing water from the gun-barrel is with an automatic water leg. This water leg usually contains an air vent, to prevent a syphoning action, resulting in a partial aeration of the water as it leaves the gun-barrel causing a ferric hydroxide floc to form. Further aeration occurs as the water is poured into the skimming tank. As this floc comes in contact with oil it is coated with the oil to the extent that the density of floc and oil is made to equal the water. Under such conditions the floc will not settle but will stay exactly in the position it is placed. This is the cause of the formation of the so called "floating floc." The oil associated with this floc effectively prevents further growth of the particle, which means the particle size remains the same or decreases.

The only way to cause such material to settle is to form on the particle some additional oil-free floc in order to increase the density of the oil contaminated particle.

It is desirable that such floating floc be removed from the water before going to the filters. How much oil will be carried to the filters per pound of such floc can be calculated. As this oil-soaked material enters the filters and is plastered onto the face of the sand there are two results that can occur. As more and more oil is introduced the effective permeability, or the ability to permit water to pass through the filter bed, is decreased, which results in the need for applying higher and higher pressure on the filters to pass the desired volumes of water through them. When, and if, the filters are allowed to operate in such condition too long before backwashing, the quantity of oil introduced to them might become great enough that the oil may pass through the filter and be injected into the well. If such did occur the effect on the ability of the well to "take" the desired volume of water might be disastrous. It is a known fact that oil is present in most injection wells and such mechanism might account for its presence. Likewise, oil has been detected in filtered water from some salt water injection systems.

To return to the more stable oil-in-water suspensions discussed previously: As described before, the particles are stable because of an electrostatic charge on them. Nature lends a helping hand on eliminating this electrical charge. As in the case of most naturally occurring colloids, these particles carry a negative charge. In forming the floc, on the addition of alum, a positive charge is created on the particle so formed. This positively charged particle attracts the negatively charged oil particle and both are discharged and settle. The choice of an aluminum salt for this purpose is particularly fortunate for the trivalent aluminum ion is very effective in destroying the electrical charge on the oil droplet. A more complete discussion of the theory of flocculation will be presented in a later paragraph.

The importance of the removal of oil from the water and the possible effect of poorly skimmed water on all the subsequent operations of the treating plant and injection system make it imperative that more thought and attention be given to this phase of salt water treatment.

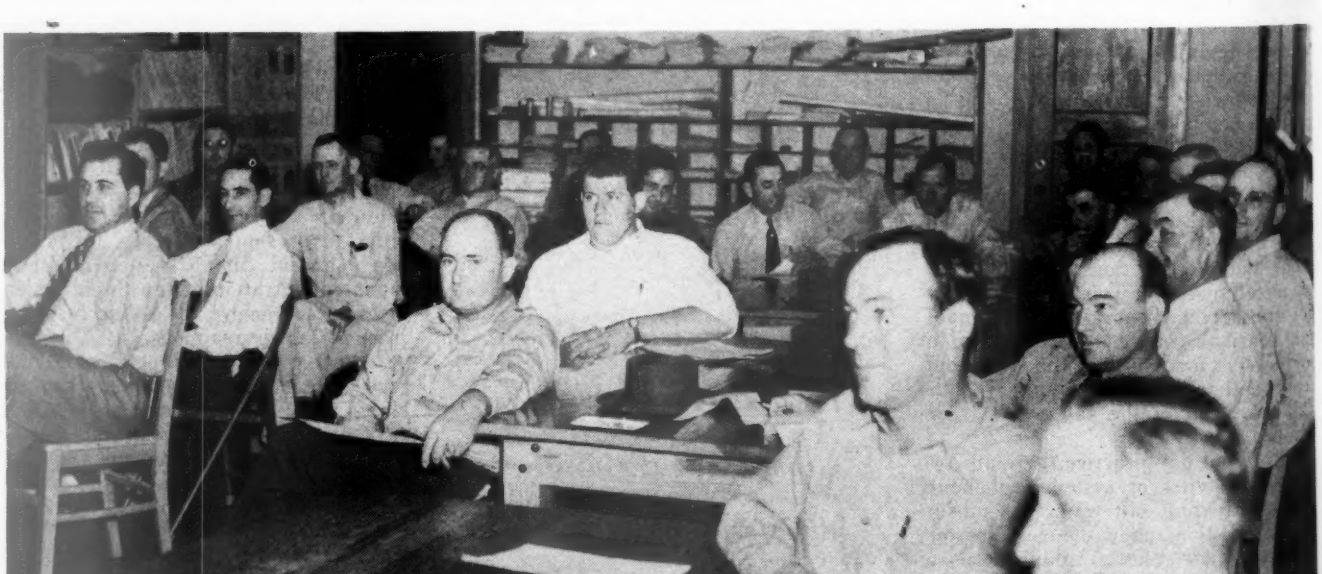
Aeration. Aeration of the salt water is done for three reasons, namely:

1. To remove any gases that might be in the salt waters. The salt waters contain a large amount of carbon dioxide (CO_2) resulting from the breakdown of the bicarbonates, petroleum gases, dissolved in the water at rather high partial pressures and possibly some noxious gases, such as hydrogen sulphide (H_2S), resulting from secondary reactions like reduction of the sulphates.

2. To oxidize the iron and similar compounds from the ferrous, or soluble, state to the ferric, or insoluble state.

3. To form aerobic conditions in the salt water in order to aid in the control of bacterial activity in salt water.

It has been mentioned previously that



A class of operators, superintendents, farm bosses, and pumpers studying the technique of salt water disposal at Kilgore, Texas.

the iron and calcium are present in the water as their respective bicarbonates. These unstable compounds break down according to the following reactions:

$$\left.\begin{matrix}(HCO_3)_2 \\ (HCO_3)_2\end{matrix}\right\} \gtrless \begin{matrix}CaCO_3 + H_2CO_3 \\ FeCO_3 + H_2CO_3\end{matrix} \gtrless H_2O + CO_2$$

It may be seen that these bicarbonates exist in equilibrium with the carbonates and carbonic acid, which in turn is in equilibrium with water and carbon dioxide. The extent to which the equilibrium is shifted to the right or to the left is a function of the partial pressure of carbon dioxide.

In aeration the salt water containing the bicarbonate at a high partial pressure of carbon dioxide is brought into equilibrium with air at a low partial pressure of carbon dioxide. As a result the carbon dioxide leaves the salt water and goes into the air in an effort to equalize the partial pressure of carbon dioxide in the water and in the air. To hasten this reaction for removing the carbon dioxide, the water is made to have a very large surface, either by spray towers or slabs or blowing air bubbles through the water. In order to make the aeration complete and remove all the carbon dioxide, it is necessary to bring a continuous supply of fresh, carbon dioxide free air in contact with the water. Since aeration removes carbon dioxide, an acidic gas, this reaction tends to increase the pH of the water.

For these reasons, it is desirable that thought be given to the type of aerators to be used and the selection of the site for their construction. Thus we see that the chemical reactions again affect the design and layout of the salt water treating system.

A characteristic of subsurface waters is the presence of iron compounds dissolved in the ferrous state. Such a state, at the pH of salt water, is possible only when air is completely excluded from the water. As soon as air comes in contact with the salt water these ferrous compounds are oxidized to the ferric compounds, which are almost completely insoluble in the salt water. Thus the aeration serves to remove the iron from the salt water. The reaction for this oxidation may be written as follows:

$$4FeCO_3 + O_2 \longrightarrow 2Fe_2O_3 + 4CO_2$$

A more complete picture of the chemistry of aeration may be had from consideration of the following reaction, which includes not only the oxidation of the iron but also the breakdown of the bicarbonates as discussed before:

$$4Fe(HCO_3)_2 + 2H_2O + O_2 \longrightarrow 4Fe(OH)_3 + 8CO_2$$

Since in this reaction there are formed 8 molecules of carbon dioxide any previous remarks relative to the need for continuous supply of fresh, carbon dioxide free air still are true.

Quite frequently a reaction, either bacterial or chemical, occurs in the water that produces hydrogen sulphide by reducing the sulphates in the salt water. If and when this reaction occurs upstream, or before aeration, the hydrogen sulphide promptly reacts with the iron in the water forming iron sulphide. This is the reaction responsible for the "black water" condition sometimes encountered.

The reaction for the reduction of the sulphates present in the salt water may be written as follows:

$$Ca(SO_4) + CH_4 \longrightarrow CaS + CO_2 + 2H_2O \longrightarrow CaCO_3 + H_2S + H_2O$$

$$H_2S + Fe(HCO_3)_2 \longrightarrow FeS + 2H_2CO_3 \rightleftharpoons 2H_2O + 2CO_2$$

It may be seen that these reactions are expressed as purely chemical. It must be presumed that when conditions are right these reactions will take place by simple chemical means and cases are known where these reactions have taken place as written. It is equally well established that bacteria serve as powerful catalysts to promote chemical reactions. It would seem impossible to rule out either reaction without first obtaining more information than is now available. However, in any case it is the presence of hydrogen sulphide or iron sulphide, which may be formed, that causes any difficulty from this condition.

Fortunately, these compounds are rather unstable and are readily susceptible to oxidation. The common reagents used to oxidize these sulphides are air and chlorine. The reactions may

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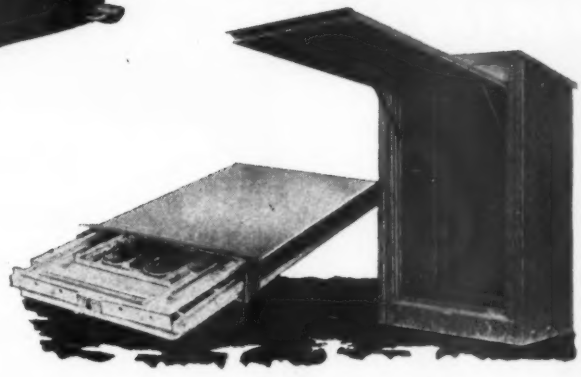

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be written as follows:

$$H_2S + Cl_2 \rightarrow 2HCl + S$$
$$2FeS + 3Cl_2 \rightarrow 2FeCl_3 + 2S$$
$$FeCl_3 + 3H_2O \rightleftharpoons$$
$$Fe(OH)_3 + 3HCl$$

These reactions both produce an acid, hydrochloric acid, and therefore have a tendency to lower the pH of the water. When the black water condition is oxidized with air the following reactions take place:

$$2H_2S + O_2 \rightarrow H_2O + 2S$$
$$4FeS + 3O_2 \rightarrow 2Fe_2O_3 + 4S$$
$$Fe_2O_3 + 3H_2O \rightleftharpoons 2Fe(OH)_3$$

It will be noticed that these reactions produce no acidic compounds, which leaves the pH of the salt water unaffected. In both types of reactions free sulphur is produced. This sulphur is formed in a colloidal state, which accounts for the milky color the water assumes after the black water has been oxidized with either air or chlorine.

Of additional interest with respect to these above discussed reactions is the effect on the future of the water if the reactions are not carried to completion and the sulphides completely removed. The presence of the sulphides renders the waters reducing and makes possible the resumption of the reaction for the production of more sulphide. Such reactions would take place in the main settling pit and also downstream from the filters, which would give rise to the black water condition in the injection well probably to the extent that iron was present in the filtered water through either incomplete treatment or corrosion of pumps, fittings, and tubing.

Hydrogen sulphide in itself would have no ill effects on the injection well and is harmful only to the extent of the secondary reaction, which produces the metallic sulphides that are evidenced in the black waters.

Sterilization. The possibility of bacterial contamination of the salt water is ever present. In order to overcome this possibility the waters are treated most commonly with chlorine and sometimes with a hypochlorite, which hydrolyzes to give chlorine.

The bacteria most commonly associated with salt water disposal is the anaerobic sulphate reducing type, namely the vibrio desulphuricans, which thrives best at a temperature of 100°F. to 120°F.

The word anaerobic means "without air," which means that in order to thrive the bacteria must not be exposed to oxygen or, chemically speaking, must be maintained in a reducing environment. It becomes clear that by the introduction of an oxidizing substance, such as chlorine, the reducing environment is changed to one of oxidizing character. This change is the major role played by chlorine when considered as bacterial control only. Chlorine is toxic, however, to most bacteria in itself, a property that plays a secondary role in treating salt water.

Salt water as produced has the reducing properties necessary for maintaining bacterial growth. Enough chlorine must be added to destroy this reducing power and also give the water an oxidizing power of its own in order to prevent future growth of bacteria.

Coagulation and settling. With the use of the coarse sand or rapid filter the need for introducing a reasonably clear water becomes evident. If too much foreign matter that is of too small particle size must be removed from the waters, the pressure drop becomes excessive and inefficient filter operation results. The use of coagulants became widespread in order properly to prepare the water for filtration through the rapid sand filter.

In nature most colloidal particles possess a negative electrostatic charge that causes such particles to remain in stable suspension indefinitely. One of the easiest and best ways to neutralize the negative charge is to form a positively charged colloidal particle in the water. As the result of the attraction of the two oppositely charged particles, collisions between them occur causing a mutual discharge, or neutralization, of both particles. By a succession of such collisions and by mechanical contacts the particles grow to such size they begin to settle.

If a particle similar to a wad of pine needles can be visualized some idea of the structure of these electrically neutral particles can be had. As such a mass comes in contact, on settling through the water, with another similar mass the two intertwine and are held together mechanically.

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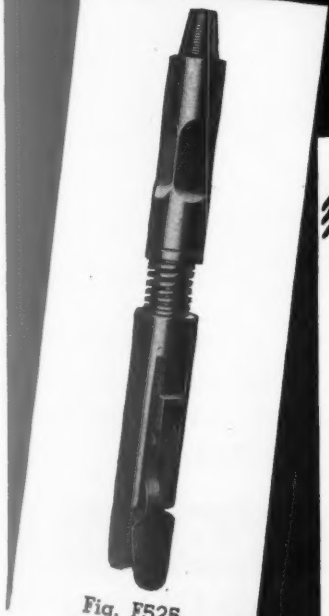

Fig. F525

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If the two states of the particle are kept in mind the physics, or mechanical control, of flow velocities can be understood. While the waters contain a relatively large number of electrically opposite charged particles, a rapid current increases the chances of the particles to collide and neutralize each other. As soon as the electrical properties have been destroyed and the mechanical phase of coagulation becomes dominant, it is desirable to decrease the rate of flow of the water. While motion increases the chance for collision, too rapid movement causes the particles, or floc, to break up. A properly designed system provides for suitable fluid velocities in order to coagulate completely and settle the water. Naturally the design of the system must provide for thorough mixing of the coagulating materials with the water prior to flocculation and settling.

In the choice of alum, (aluminum sulphate), consideration was given not only to the charge on the colloidal particles but also to its reactions with the salt water and the constituents in the water. Two basic reactions between the salt water and the alum are of interest. First is a reaction with the alkalinity of the water as illustrated by the reaction:

$$Al_2(SO_4)_3 + 3Ca(HCO_3)_2 \rightarrow 2Al(HCO_3)_3 + 3CaSo_4$$

$$\downarrow$$

$$Al(OH)_3 + 3CO_2$$

In other words, the alum reacts with any unstable bicarbonates and converts them to the stable sulphate and is in turn hydrolyzed to aluminum hydroxide, the floc, and carbon dioxide. The aluminum bicarbonate break down is an equilibrium reaction and might not be complete toward the aluminum hydroxide, which might permit a small quantity of aluminum to pass through the filters and be hydrolyzed in the well bore. Small amounts of aluminum have, in fact, been found at the bottom of injection wells.

The second, and by far the most important, reaction between aluminum sulphate and the salt water is a straightforward hydrolysis reaction as follows:

$$Al_2(SO_4)_3 + 6H_2O \rightarrow 2Al(OH)_3 + 3H_2SO_4$$

In this reaction it will be noticed that three molecules of sulphuric acid are produced for each molecule of alum used. The formation of this acid lowers the pH of the water and represses the hydrolysis reaction. At pH values below five or six the alum is soluble in the salt water without forming the floc.

The primary purpose for the addition of lime, an alkaline compound, to the water is to prevent the lowering of the pH of the water through the use of alum. The reaction to increase the pH is as follows:

$$H_2SO_4 + Ca(OH)_2 \rightarrow CaSO_4 + 2H_2O$$

An additional reaction resulting from the use of lime, (calcium hydroxide) is in neutralizing any remaining bicarbonates that might be present. For instance:

$$Ca(HCO_3)_2 + Ca(OH)_2 \rightarrow 2CaCO_3 + 2H_2O$$

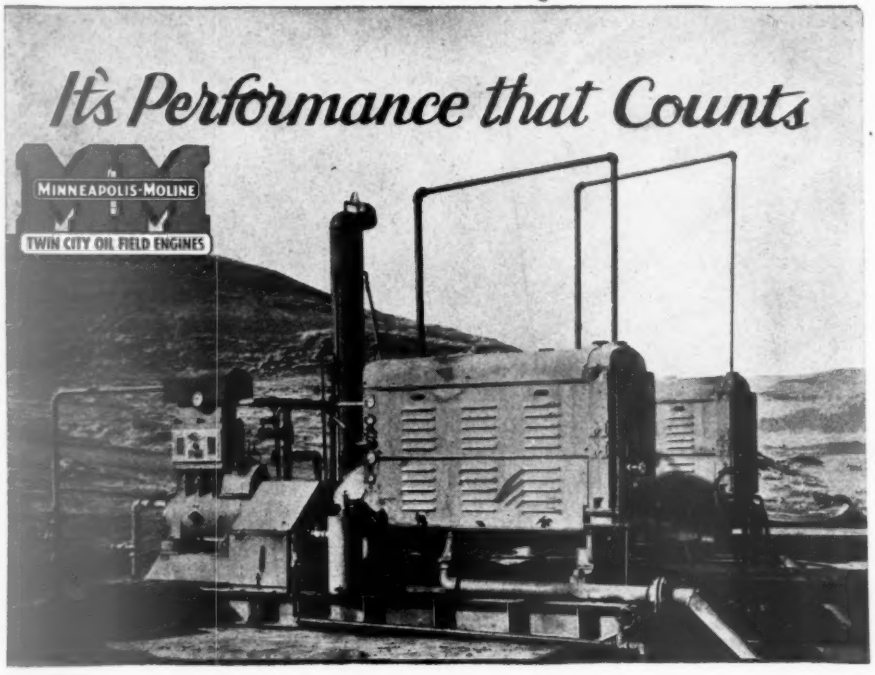
It is conceivable that the calcium carbonate formed by this reaction might, being present in small amounts, be colloidally suspended and as such be stable. Stirring with solid $CaCO_3$ would tend to coagulate the particles of calcium carbonate giving the appearance of a calcium carbonate supersaturation. Passing the water containing a stable suspension of calcium carbonate through a filter would tend to flocculate the solid, which would adhere to the pores in the sand causing the calcium carbonate cementation often encountered in filters after long periods of operation. It would appear preferable to stabilize completely the carbonates in the aeration step rather than precipitate them with lime after flocculation.

With all the above described reactions carried to completion we arrive at the filter with a water that is sterile, relatively clear, and stable with respect to iron and calcium carbonate. However, the total solids remain relatively unaffected. The pH is unchanged, and the water is more corrosive to iron. ★★★

(Installment No. 10 of the Salt Water Disposal Classes will be published in an early issue.)

Seeks Brazilian aid

Dr. S. Froes Abreau, director of minerals division, Instituto Nacional de Technologis, Rio de Janiero, Brazil, is in the United States conferring with geologists, engineers, financiers and executives of large oil firms urging them to study the huge South American Republic. Brazil has huge petroleum reserves, but only one proven area, Abreau said.



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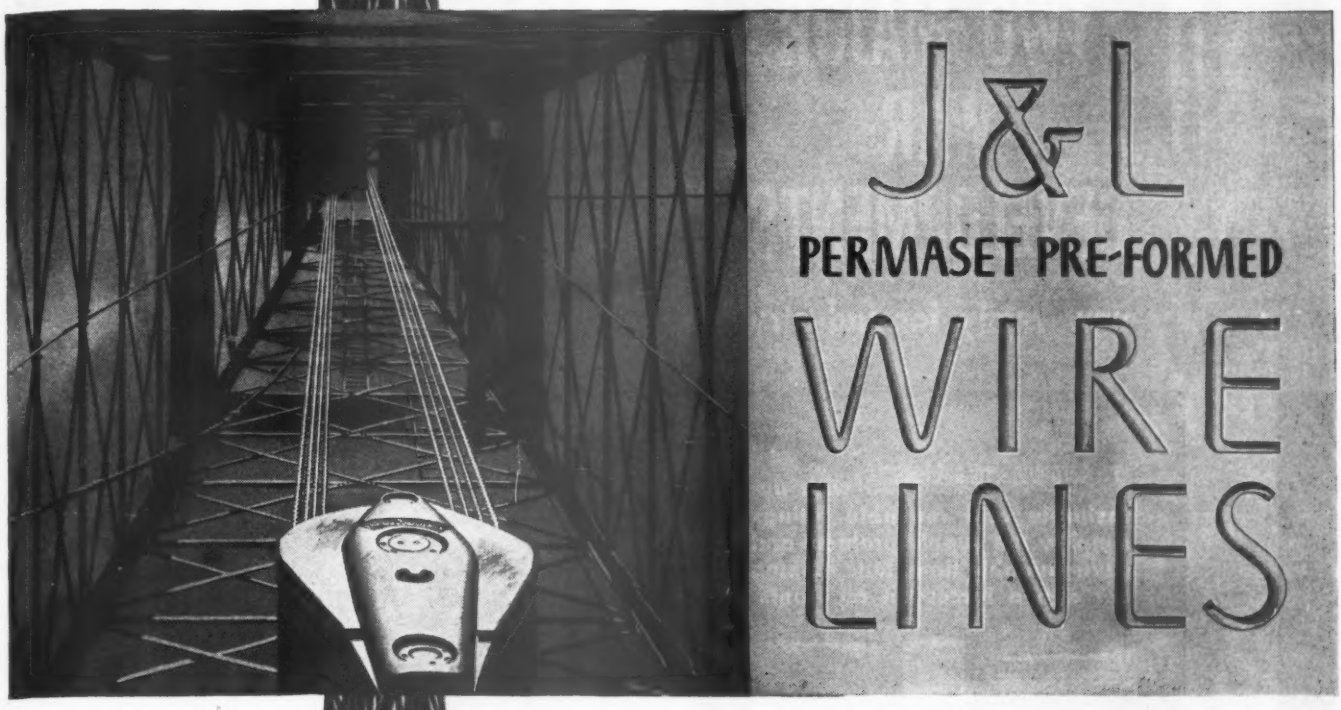

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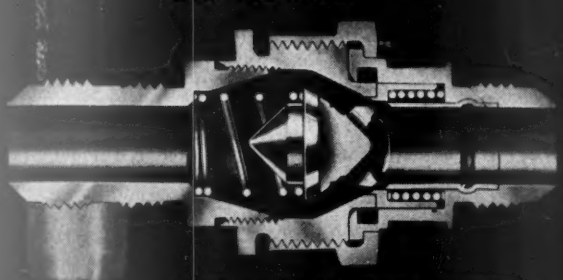

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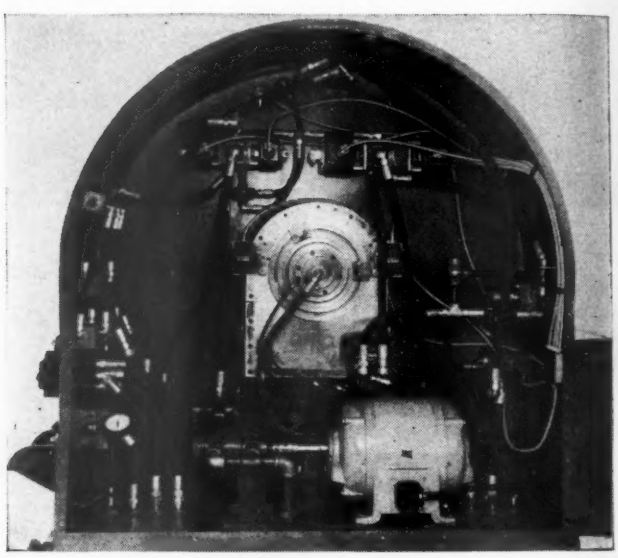
The simplicity of using these flexible lines in place of rigid lines not only eliminates many questions of design layout previously necessary to accommodate fixed lines, but also permits complete assembly of the machine itself, followed by the subsequent application of these flexible lines, accommodating themselves to any space available, over or around various parts.



The above view illustrates the rear of a special milling machine with three hydraulically driven milling heads. Aeroquip hose lines are handily adapted to all positions and connections where rigid tubing would have required more extensively engineered outlet and space arrangements. At the same time performance under extreme vibration has been greatly improved and failures or ruptures are practically eliminated.

Aeroquip hose lines, which are "AN" standard on U. S. Army and Navy aircraft, are suitable for all hydraulic actuation, including installations for lubrication, pressure switches and power transmission.

The detachable fitting feature simplifies maintenance, permitting quick attachment, and continued re-use of the individually interchangeable fitting parts with new hose lines "tailored to the job" on the spot by simply cutting new Hose to the desired length.

The adoption of flexible Hose Lines to Machine Tool installations is gaining rapid recognition among machine tool designers and builders.

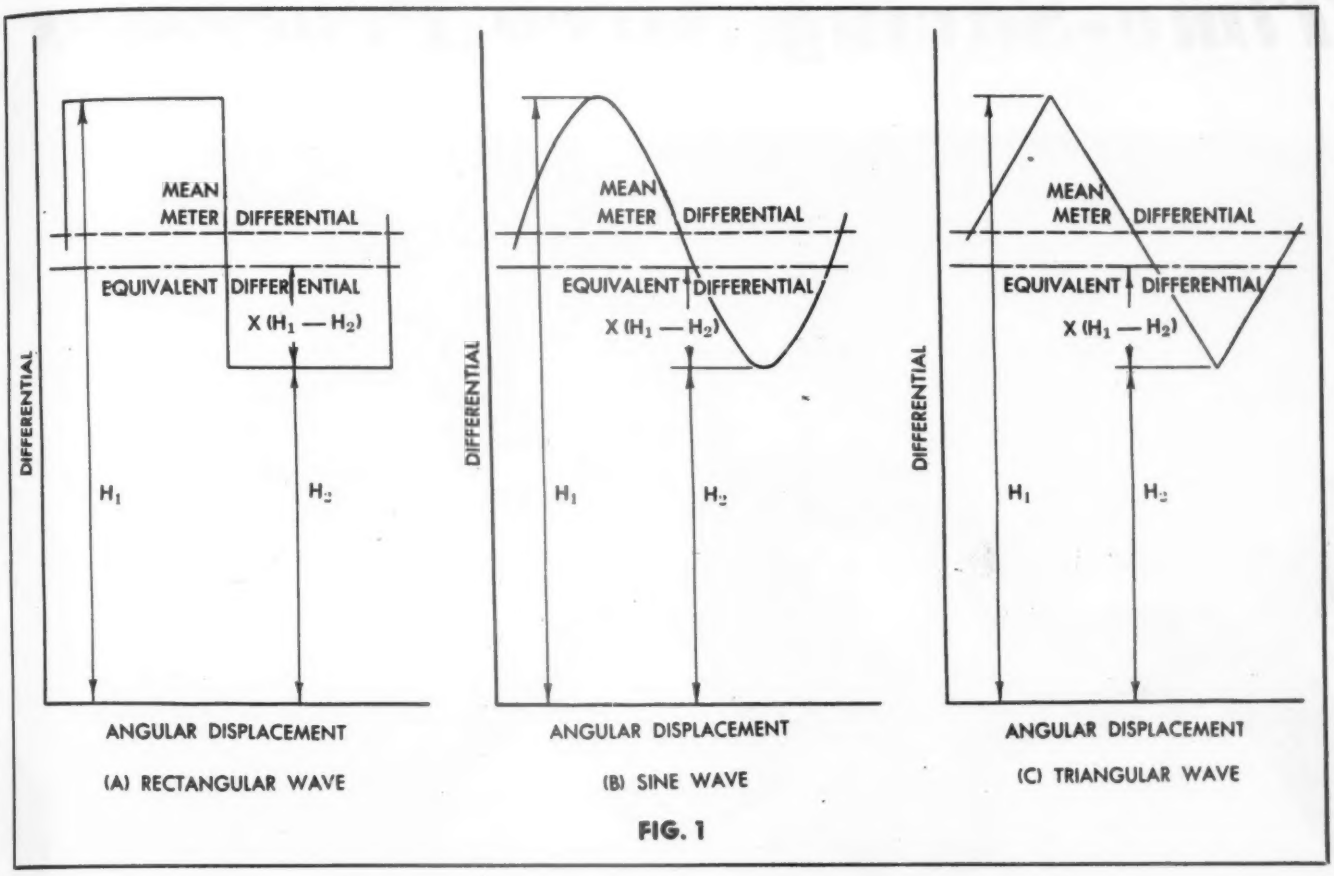


FIG. 1

READING A WIDE-LINE FLOW METER CHART

S. R. BEITLER, *Professor of Hydraulic Engineering*
E. J. LINDAHL, *Assistant Professor of Mechanical Engineering*
Ohio State University

EXCLUSIVE THE pen of a flow meter that is subjected to intermittent flow makes a line on the chart of considerable width. In computing the flow from these charts there has always been some question regarding the proper place to take the differential reading in order to obtain the correct rate of flow. In most cases the reading is taken in the center of the wide line though it has been suggested that the reading be taken one-third of the line width from the lower edge of the line.

In order to determine the place to read for the greatest accuracy three different types of intermittent flow were analyzed from a mathematical standpoint. A theoretically determined curve was then plotted that gives the proper place to read the differential to obtain accurate results.

It should be emphasized that this analysis is for conditions in which the rate of flow changes so slowly that the differential pen is able to follow the changes in pressure closely. In the case of rapid pressure variations, of the type called pulsating flow, there may be a large variation in differential pressure and the line on the chart may not be any wider than for normal flow whereas, if the line is wider than normal, the true range of differential pressures may be quite different from that indicated on the chart.

Three types of intermittent flow analyzed mathematically to determine the place to read for greatest accuracy.

The three different shapes of time-differential waves dealt with are shown in Fig. 1. In each case one cycle of the wave is shown (from the start of one wave to the start of the next). The first wave has a rectangular form in which the pressure increases and decreases instantaneously and remains constant at its maximum and minimum values; the second is a sine wave, and the third is one in which the pressure is varying continuousy from the maximum to the minimum with straight line variation. For each of the curves in Fig. 1 H_1 is the maximum value of the actual differential, H_2 is the minimum value of the actual differential, and x is the per cent of the line width that must be added to the minimum value of the actual differential to give a differential that gives a flow reading equivalent to the flow given by the fluctuating wave. K is the meter constant.

For the symmetrical rectangular wave in Fig. 1 the true rate of flow is

$$Q = \frac{H_1^{1/2} + H_2^{1/2}}{2}$$

and the equivalent rate of flow is $K\,[H_2 + x\,(H_1 - H_2)\,]^{1/2}$. The value of x

(Continued on Page 138)

Time-Saving Airco Processes

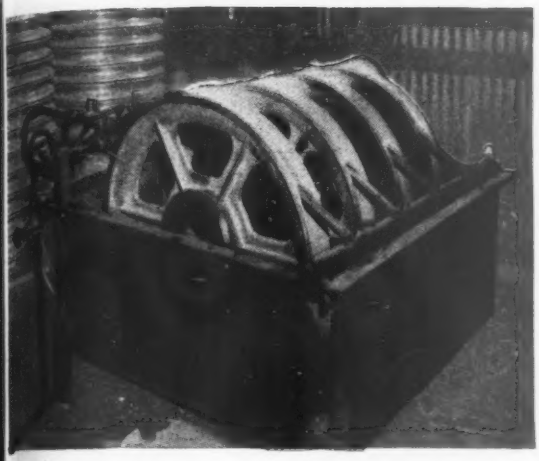
IN meeting the urgent need for speed during its wartime expansion, the petroleum industry has made ever-increasing use of both the oxyacetylene flame and the electric arc. These fast-working tools are providing valuable aid to the industry in many ways—in welding transmission pipe lines and refinery piping; in the fabrication, erection and alteration of structural units; in re-building and repairing worn and broken equipment of every type.

In addition to the processes shown on these pages, other Airco metal-working methods for the petroleum industry include: braze welding, hard facing, sil-brazing, scrap cutting, machine gas cutting, plate edge preparation, flame cleaning and dehydrating. Airco's Applied Engineering Department will provide information and assistance on any of these processes. For further details call or write any Airco office, or Dept. P. E. at the New York office.

Pipe Welding by use of the electric arc or the oxyacetylene flame has played an important part in helping the industry keep pace with wartime expansion needs. Whichever method is used the resulting joints are always stronger than the pipe itself.

AIRCO

for Oil Field and Refinery

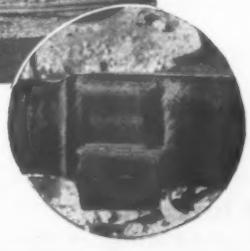


Flame Hardening sheaves with the oxyacetylene flame gives extra hardness in the cable grooves; prolonging their service life. Many types of equipment are made to last longer, wear better by flame hardening areas exposed to heavy wear.

Arc Welded Fabrication helps to meet emergency needs for pipe fittings not immediately available. Shop fabrication by this method is equally useful in reclaiming damaged equipment and in producing special equipment.

Airco Portable Pipe Cutting and Beveling Machine is widely used for removing frozen fittings as shown, and also for simultaneously cutting and beveling pipe before welding. Crank-operated, this handy machine makes fast, accurate cuts.

Structural Welding with the electric arc speeds the construction of storage tanks and many other units for oil field and refinery. This method saves both time and steel.



Flame Gouging is an important Airco process used for salvaging vital petroleum equipment. The close-up view shows how welded or shrunk-fit tool joints can be removed from drill pipe without damaging the drill pipe threads.

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The two ditcher teeth pictured above were used on the same machine and operated under identical conditions.
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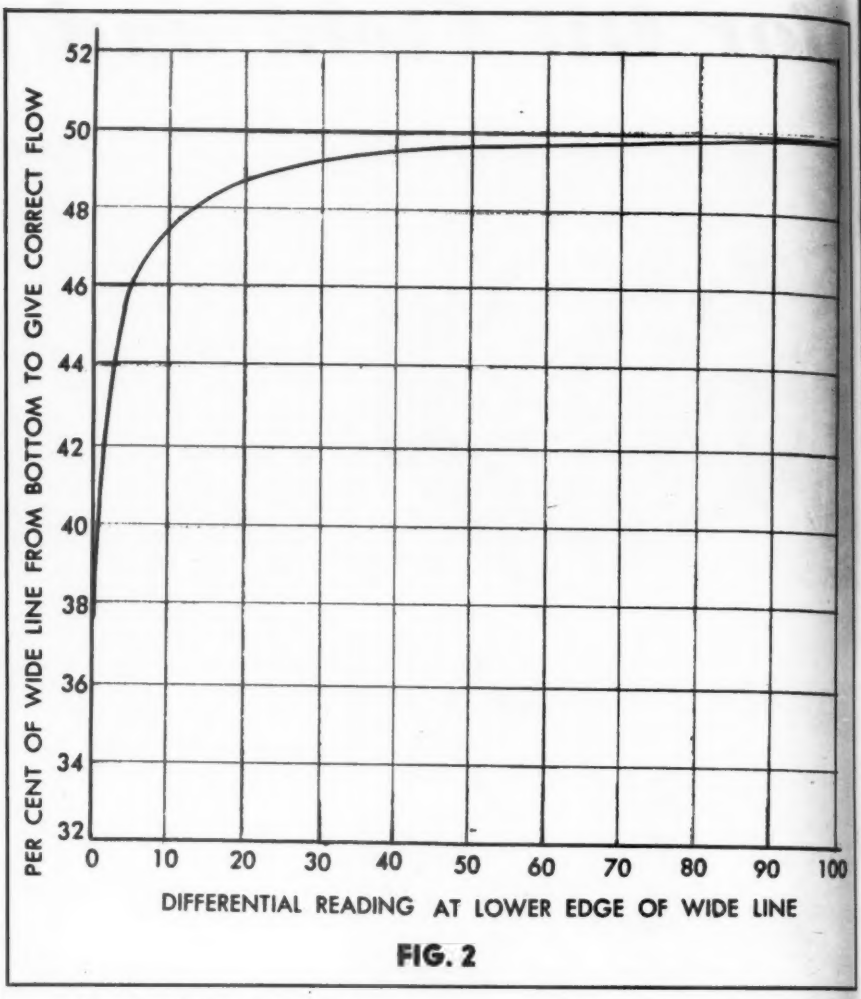

FIG. 2

(Continued from Page 135)

is then found from

$$[H_2 + x\,(H_1 + H_2)]^{1/2} = \frac{H_1^{1/2} + H_2^{1/2}}{2}$$

For the sine wave the true rate of flow is given very closely by

$$K\left[\frac{H_1 + H_2}{2}\right] \times \left[1 - 1/16\left(\frac{H_1 - H_2}{H_1 + H_2}\right)\right]^2$$

and x is found from

$$[H_2 + x\,(H_1 + H_2)]^{1/2} = \left[\frac{H_1 + H_2}{2}\right]\left[1 - 1/16\left(\frac{H_1 - H_2}{H_1 + H_2}\right)^2\right]$$

For the triangular wave the true rate of flow is

$$\frac{2}{3}\,K\left[\frac{(H_1)^{3/2} - (H_2)^{3/2}}{H_1 - H_2}\right]$$

and x is found from

$$[H_2 + x\,(H_1 + H_2)]^{1/2} = \frac{2}{3}\left[\frac{(H_1)^{3/2} - (H_2)^{3/2}}{H_1 - H_2}\right]$$

It is probable that the actual wave forms for intermittent flows are not like any of these but they do have irregular shapes. The results of computations from the above equations show that if the period above the mean differential is approximately the same as the period below the mean the shape of the wave is relatively unimportant except for very low mean differentials.

These computations also show that the place on the wide line that gives the correct value of flow varies less with the absolute width of the line (lines up to 15 in. in width were studied) than it does with the shape of the wave form. As the shape of the wave is unknown the only variable that has been considered in determining the equivalent differential is the minimum value of the wide line differential. Fig. 2 has been plotted to indicate the location of the reading on the wide line to give the most accurate computation of flow.

It will be noted that for lines of 15 in. or less in width and with the lower edge of the line above 10 in., it will be possible to read at the middle of the wide line and obtain a flow computation as accurate as can be expected for this condition. If the bottom of the line is lower than 10 in., then it would be better to read at some other place less than one-half way between the bottom and top lines. ★★★

Crude oil increase

Crude oil production in the United States is expected to increase 150,000 bbl. over last year's daily average, according to the Petroleum Industry War Council. Production should reach 4,737,000 bbl. daily, the council said. It estimated that overall yields of gasoline will be less than the 1944 rate of 39.4 per cent.

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CASING DESIGN

By **NORMAN C. WELLS,** *Production Engineer*

EXCLUSIVE "TAILOR-MADE" casing strings become increasingly more the rule than the exception with increase in depth below 5000 ft. As the depth approaches 10,000 ft., more or less, the designer's problem becomes more complicated even to the extent of material available. The approach to these various problems concerning design, despite certain shortcuts that have been devised, calls for a thorough knowledge of the basic considerations involved. For example, when a designer uses arbitrarily established safety factors, he knows the premises upon which they were based and can apply them, or modify them, intelligently to meet unusual conditions. He also has a limited selection of material available to accommodate his design requirements. When these requirements cannot be entirely met, having a full understanding of the elements involved, he might care to make some special provision to obtain the proper degree of protection. A general discussion of the problems is presented here with emphasis upon the often neglected surface string and the top part of the casing string proper, particularly concerning deep wells.

First of all, the designer has certain safety factors that he has set up or has had set up for him. These are usually based upon minimum values for properties of the steel being used. Any other basis would require adjustment accordingly. The following values are used for an example. They are somewhat in line with those used by most operators, the value for bursting being subject to the greatest variation. They are all based upon new API values.

Collapse	*1.12*
Bursting	*1.80*
Tension	*1.75*

The values, of course, mean little without some explanation of the basis of their determination. Safety factors are purposely made high or low depending upon the conditions that are assumed. For the above factors, these conditions might be somewhat as follows:

● **Collapse.** The casing is assumed to be at atmospheric pressure on the inside and surrounded with mud exerting a pressure of 55 lb. per sq. in. per 100 ft. At each critical point in the string, correction is made for the effect of the weight of casing hanging below it. This biaxial loading reduces the collapse value of the casing, depending upon the type of steel used. Information on this correction factor is published by the steel companies in convenient form for use by the designer. It is usually based upon API minimum collapse pressure and average yield strength.

Counteracting the weight of casing hanging below the critical point being considered there is some buoyancy effect, which might be considerable where the casing is "floated" in. This is often discounted because of the relatively low factor of safety used. In effect, it becomes an additional factor of safety during the stage of running the casing and is taken advantage of as such.

The set cement provides a certain amount of protection to the lower part of the casing as far as collapse is concerned. For conservative design, however, this should be disregarded due to the fact that something might go wrong with the cementing job. A successful shut-off might be obtained without being able to put away behind the casing nearly the amount of cement that was planned. The operator would not then wish to go through the procedure that would be required merely to provide cement protection for the casing.

● **Bursting.** The basis for determining internal pressure may lead to the choice of a safety factor much different from that shown. Where conditions are well known, a factor of 1.1 is often used. This, however, is low even though it is based upon minimum values. The critical point in bursting is usually above the shoe of the surface pipe. At least the very top of the casing is surrounded by atmosphere, and this condition might extend down into the surface pipe if the fluid between strings should leak away.

Where formation pressures are unknown in the area, they are frequently assumed on the basis of 0.50 lb. per sq. in. per ft. of depth. Calculations are then made to correct this for a gas column to the surface to determine surface, or casing, pressure. The accompanying curve, entitled "Surface Pressure vs. Depth of Gas Column," may be used to facilitate these determinations.

If an unexpectedly high pressure is encountered, a last minute change in design might become necessary or some special provision made to accommodate the weakness of the casing in bursting.

Normally, the bursting strength of the casing string proper above the shoe of the surface pipe, or a point just below this, is the only critical section of the string. Occasionally, an intermediate low pressure sand will create another critical section in bursting.

In the case of surface casing, the designer is vitally concerned with bursting. Here, he must consider the not unlikely chance of a leak in the casing string proper. The surface casing must be designed to withstand this pressure or else provision must be made to relieve it. In any event, a periodic check should be made of "between strings" pressure as long as high casing pressure exists during the operation of the well.

● **Tension.** Tension is usually critical only while running, cementing, and landing the casing. Effecting the factor of safety, the designer again has buoyancy to enable him either to reduce his factor of safety or to take advantage of as an additional factor of safety. Most designers prefer the latter course, and such is being adopted in this discussion. Buoyancy of the metal alone and any floating effect are, therefore, disregarded. The effect of buoyancy, in fact, is momentarily destroyed in part whenever the casing is picked up out of the slips.

Working the pipe after reaching bottom should be taken into consideration where this is done. The tension required to do this will often far exceed the offsetting buoyancy effect. There should be some collaboration between the designer and the man responsible for the running of the casing so that a limit may be set as to the amount of pull that may be safely applied. The pipe should not be worked beyond this limit.

Split joint of new 7-in. O.D. SS-28-lb.-N80 casing. Failure occurred when hydrostatic test pressure reached 1750 lb. per sq. in. Length shown is 25 ft. A 14-ft. length held by approximately 6 in. in circumference fell off in moving from well rack to yard.

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Lunkenheimer Company	Valves, Steam Specialties
Merco Nordstrom Valve Co.	Plug Valves
Oil Center Tool Company	Heads, Xmas Trees
Pittsburgh Steel Company	Seamless Casing, Drill Pipe
Reed Roller Bit Company	Rock Bits, Valves, Tool Joints
Republic Steel Corp.	Casing, Tubing, Line Pipe
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Tube Turns, Inc.	Tube Turns, Welding Fittings, Flanges
Unit Rig Company	Drilling Rigs
Vietaulic Company of America	Couplings

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● **Arbitrary factors.** In certain cases there will be allowances made by the designer for such contingencies as corrosion, wear, squeezing, gun perforating and directional hole. Of these, only allowance for squeezing can be calculated with any degree of accuracy. The others must be arbitrarily compensated for. Even the effect of a future possible squeeze job is often difficult to forecast.

● **Safety factor application.** The application of safety factors during the various stages of operation from the time the casing is started into the hole to the abandonment of the well may be segregated into critical stages somewhat as follows:

Surface casing

1. Running in. Tension.
2. Cementing. Bursting, collapse, and tension.
3. Drilling through. Wear.
4. Blow-out control. Bursting.
5. Production. (Leak in inner string.) Bursting.

Casing string proper

1. Running in. Tension.
2. Cementing. Bursting, collapse, and tension.
3. Landing. Slip notching and crushing, I.D. for passing tools and tension.
4. Blow-out control. Bursting.
5. Squeeze cementing. Bursting and collapse.
6. Initial production. Bursting.
   a. Top of string. Top joint and inside of surface pipe.
   b. Opposite low pressure sands, particularly above top of cement.
7. Later (depletion) production. Collapse, corrosion and wear.

To illustrate these and some further points in connection with a deep well casing program, reference is made to the accompanying drawing, "7-in. 10,000-ft. Casing String."

TABLE 1.

Size, in.	Depth, ft.	Weight and grade	Safety factors: Collapse	Bursting	Tension	Notes
10¾	0–2250	45.5-lb. J.	1.86	0.93	5.1	*Caution.
7	0–2500	26-lb. N-LTC		1.88	1.76	29-lb. J. not available.
7	2500–4000	23-lb. N-LTC	1.61		2.05	26-lb. J. not available.
7	4000–8200	26-lb. N-LTC	1.13			
7	8200–10,000	29-lb. N-LTC	1.16			
Minimum values			1.12	1.80	1.75	

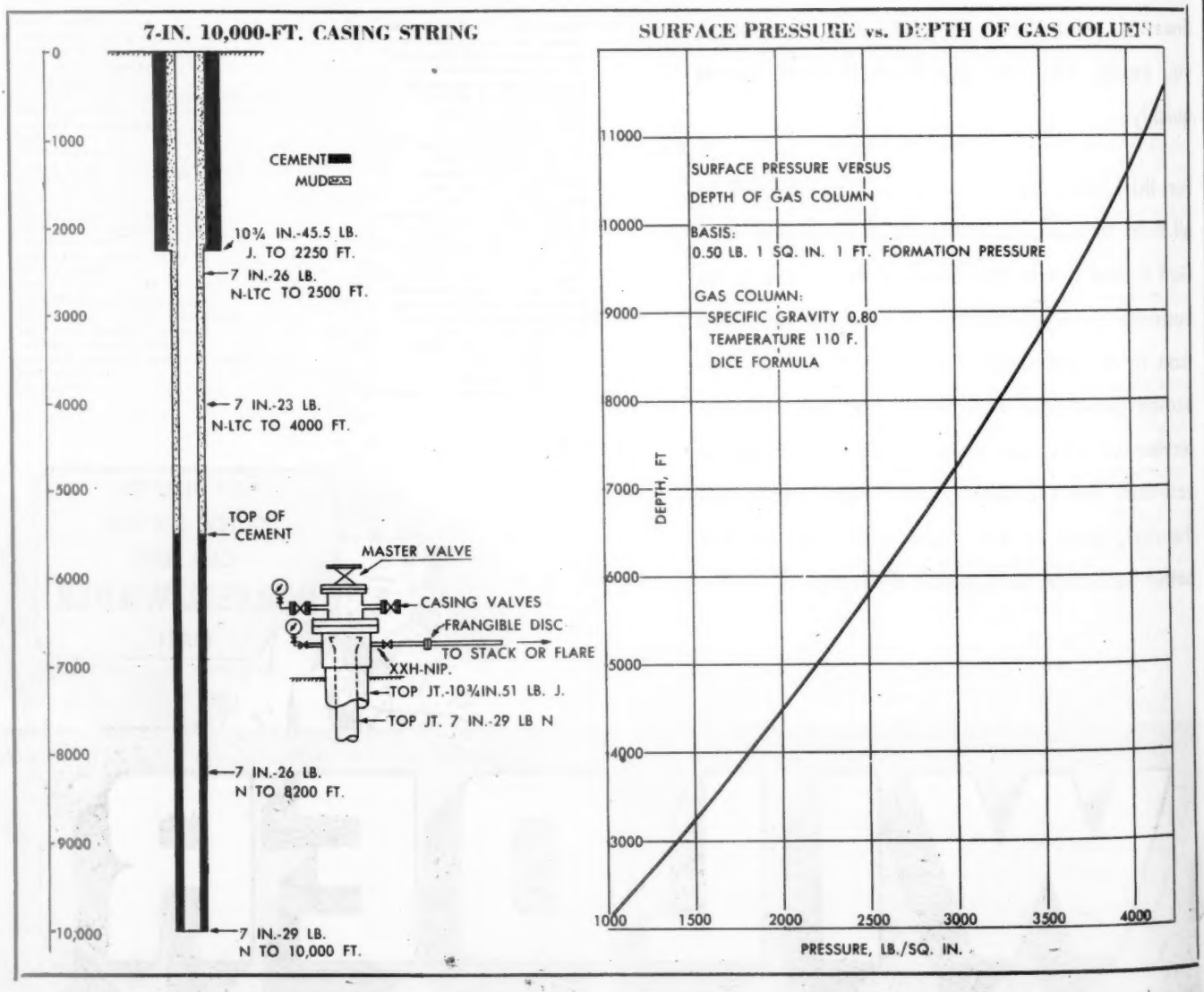
Basis of calculations:

Mud: 55 lb. per sq. in. per 100 ft.
Biaxial loading correction.
No buoyancy correction.
No cement reinforcing correction.
Bottom hole pressure 0.50 lb. per sq. in. per ft. of depth.
Correction for gas column.
Pipe is not to be worked after reaching bottom.
Arbitrary factors: None to be considered.

*If casing pressure exceeds 3580 lb. per sq. in., install frangible disc. Send note to drilling foreman and follow up.

The surface pipe is shown cemented solid to provide protection in bursting as well as possible leakage around the shoe. A heavy joint on top is used due to lack of this cement support and due to possible weakening as a result of welding to the landing head. J pipe is specified for its ductility, making it safe in bursting strength and for welding.

The 7-in. string is shown landed with a joint of the heaviest weight of pipe used in the string. The extra weight provides a minimum I.D. at this point so that any tool introduced through it will pass through the remainder of the string.



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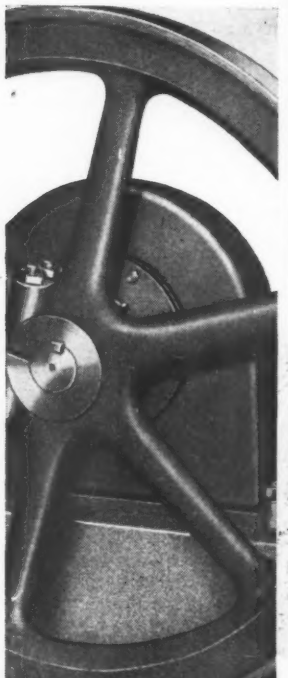
The same stamina — plus more efficient and economical operation — that has made Pattin oil country equipment famous among two generations of owners is still the ***safe*** and ***sane*** foundation upon which our present day units, of improved design, are built.

With the present trend confirming our long experience, by favoring Pattin type lower speed, single cylinder, heavy duty engines, we shall continue building them — incorporating those qualities which assure more ***reliable*** power, LONGER, and lower service cost, all resulting in greater footage drilled or oil volume lifted per dollar invested.



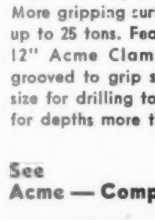


Fig. 103

Acme's 18" Safety Wire Line Clamp —

Surest, safest, strongest for deep well drilling. Non-fouling safety links — tested to 208,500 lbs. breaking load. More gripping surface, permits loading up to 25 tons. Feature of both 18" and 12" Acme Clamps is slip retainers grooved to grip sand line . . .Use 12" size for drilling to 3000 ft. and 18" size for depths more than 3000 ft.

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Also, the extra wall thickness will allow for slip notching in landing the pipe.

In the sketch of the landing arrangement, there is illustrated a frangible disc in the line from one side outlet leading to a safe point of discharge. This may be installed where pressure is encountered that was not anticipated, or, in any event, where the casing pressure exceeds the safe bursting limit of the surface pipe. Any connection that is installed ahead of the first shut-off valve should be hydraulic (XXH) in order to reduce the hazard of sand cutting.

In designing the casing illustrated, after all the preliminary work has been done and the various factors discussed have been taken into consideration, the designer will often set up a record of his final design somewhat as in Table 1.

In this case the designer has indicated that he would prefer to use J casing above 4000 ft. There is a demand arising for heavier J grades of casing, at least in the sizes most commonly used in deep wells. One alternative would be to provide a pipe with properties somewhat between those of J and N. The ductility of J casing would be very desirable in a landing joint and in the upper part of the string, where protection against bursting is so vitally important, according to the opinions of some operators. There has been some evidence to support this theory. In some instances N casing has indicated a weakness in bursting. The accompanying photograph illustrates a failure on the test rack of a joint of new 7-in. 28-lb. N seamless casing. The failure occurred when a hydrostatic test pressure of 1750 lb. per sq. in. was reached. The joint was range 3 and the failure was at a point approximately 14 ft. from one end. Hydrostatic testing had been resorted to after a similar failure in the hole.

● **Casing inspection.** There are several types of inspection that are used by operators to insure against running faulty casing into a well. They are applied to new and, in some cases, second-hand casing. A brief description of these is as follows:

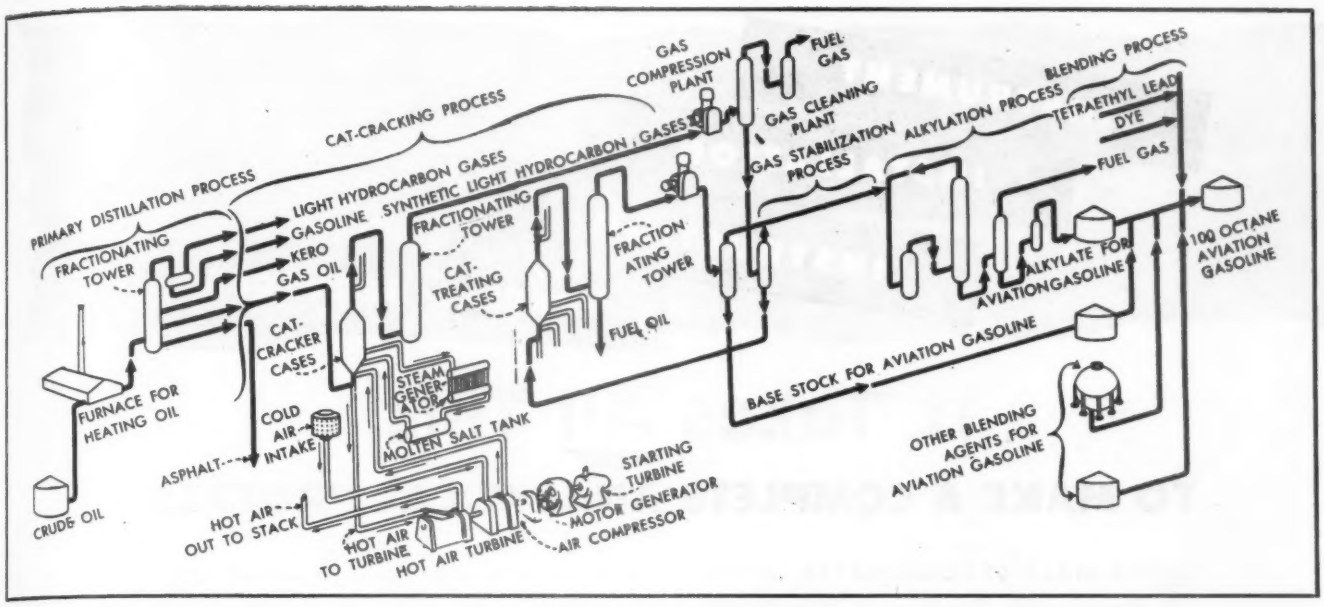
1. Threads, wall thickness and outside surface. Threads—taper, lead and height; thickness—22 in. at each end; outside surface — visual, measuring depths of pits.
2. Inside surface. Tuboscope.
3. Hydrostatic test. Bursting; thread leaks.

The theory of the wall thickness test on seamless pipe is that if the mandril starts to drift in the process of manufacture, the wall thickness at the far end of the joint will be a minimum. Checking both ends will disclose this.

In many localities, one or all of these services are available and are conducted by experienced inspectors.

For deep wells it is hoped that some relief can be obtained in the near future in the matter of protection against bursting. It is realized that from the manufacturer's standpoint it is a very serious problem. Certainly, something that is not available at the present time is desired by some designers of casing strings.

★★★



HOUDRY FIXED-BED CATALYTIC CRACKING UNIT

By **E. E. PETTIBONE,*** *Process Engineer*, Standard Oil Company (Ohio)

EXCLUSIVE THE tall towers, the maze of piping and the interlacing steel structures which constitute the new Sohio cat cracker overshadow the historic site at Cleveland, Ohio, where, over 75 years ago, John D. Rockefeller founded the Standard Oil Company. The unit, which was designed for a throughput of 16,200 bbl. per stream day, consists of two separate sections, i.e., a six case, fixed-bed cracking section with heater, fractionating and stabilizing towers, etc., and a treating section having the same general equipment but with only three cases. The unit was engineered and constructed by E. B. Badger & Sons Company. Oil first entered the cracking cases on June 16, 1944. Except for the usual necessary adjustments and minor troubles, the unit went on stream very smoothly and without difficulty.

E. E. Pettibone

*E. E. Pettibone received his B.S. (1928) and M.S. (1929) in chemical engineering from the University of Michigan. During 1937-41 he attended Case School of Applied Science and in 1942-43, he attended Fenn College.

He began his professional career in 1928 with E. B. Badger and Sons as an operating engineer supervising and instructing refinery personnel. He subsequently was employed by Abbott Laboratories as assistant plant engineer; Ralph M. Parsons Company, as design engineer, and Arthur G. McKee Company, as estimating engineer. Pettibone joined Standard Oil Company (Ohio) in 1937 as a chemical engineer in the technical service division and, since 1941, has served as process engineer.

The six case, fixed-bed catalytic cracking section of this unit converts mixed virgin gas oils from the refinery's crude stills and vacuum pipe stills to feed for the three-case treating section which subproduces finished base stock ready for blending into 100-octane aviation fuel. The by-products of these operations are catalytic gas oils, isobutane for alkylation feed, isopentane, naphtha, and fuel gases. Table 1 shows typical inspections of the charge and end products.

A ratio flow meter controls the quality of the cracking section fresh feed by regulating the amounts of virgin light and heavy gas oils that separate field booster pumps charge to the 10 by 30 ft. elevated horizontal feed accumulator. The total feed pumps take suction on this drum and push the mixed gas oils through a series of heat exchangers to the cracking furnace. Recording flow controllers split the hot feed into two equal streams that pass in parallel through the Badger tube-type heater designed for gas or fuel oil firing. Rows of venturi burners on each side of the furnace produce opposing cones of flames. The resulting hot flue gases pass from each side down into the two bottom convection sections and then back to the flues arranged under the firing platforms and out a 140 ft. brick stack. High pressure steam (450 lb. per sq. in. gage*) is combined with the oil streams, after they leave the convection sections, to insure maximum vaporization of the oil without cracking.

The two furnace outlets are merged into a single stream to enter tangentially the side of the 14 by 30 ft. cone-shaped tar separator where the heavy ends are separated by a combination of centrifugal force and gravity. Steel piston pattern pumps force the hot separator bottoms through a pipe coil submerged in a cement box cooler. Part of the cold heavy ends are returned as wash to the middle of the separator to prevent coking and the remainder go to the thermal cracking stock.

The vapors from the tar separator are commingled with a small percentage of superheated live steam to insure that the oil vapors are above their dew point before entering the catalyst cracking cases.

The six cases constituting the catalytic cracking section of this plant, are so connected that each pair of cases have their own inlet and outlet manifolds. Connected with motor valves to the lower manifold are the oil inlet, air inlet, and oil and air evacuation lines. Similarly, the oil and air outlets, air and oil repressuring and steam purge piping are

*Unless otherwise stated all pressures are lb. per sq. in. gage.

Sohio installation at Cleveland, Ohio, is designed for a throughput of 16,200 bbl. per stream day.

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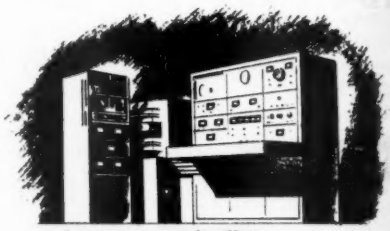

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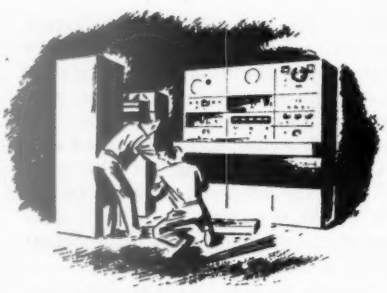

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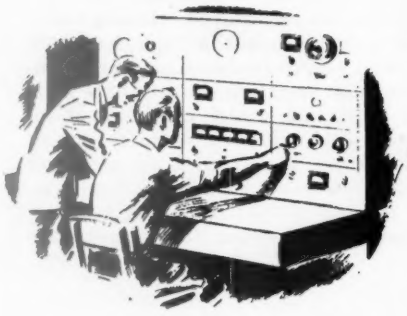

*** INSTRUCTION**—Complete instruction during installation on:

(a) Instrument theory and operation.

(b) Instrument maintenance and service.

(c) Analysis theory and practice.

*** SPECIAL SERVICES**—Engineers are available for consultation on unusual service or operating problems. Consolidated's interest in the user and his problems includes continued development of both the instrument and its application to all analysis problems. Write Department 4-L for detailed information on how this analytical tool can help with your control, research and development problems.

Average delivery time is 4 months from receipt of purchase order, and installation and training are usually completed in less than 6 months.

CONSOLIDATED ENGINEERING CORP.

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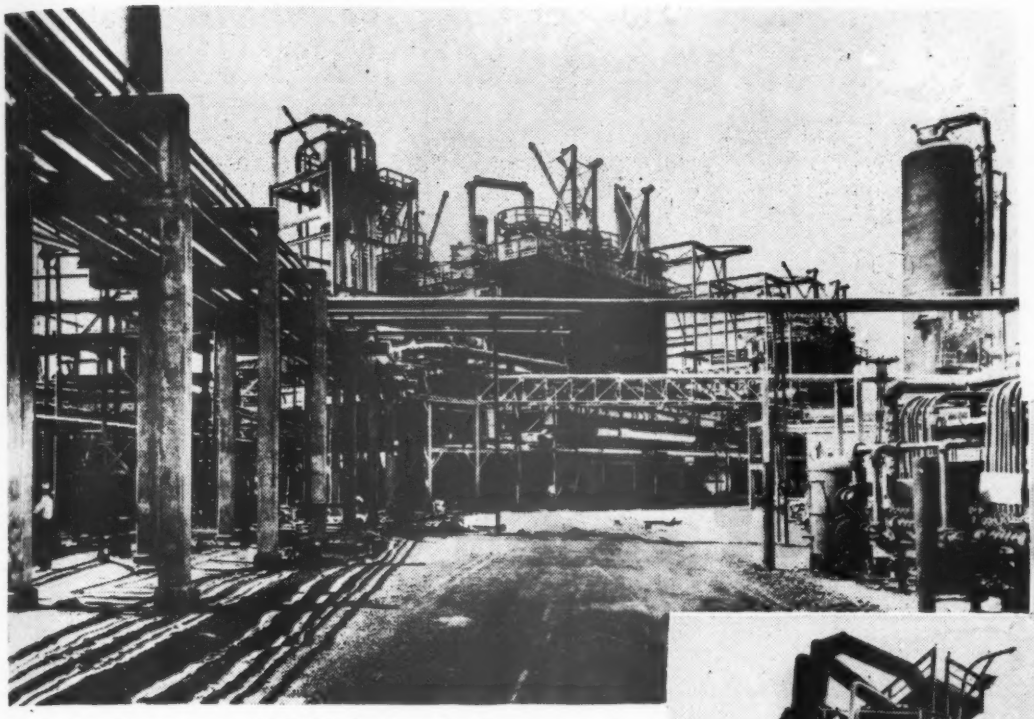
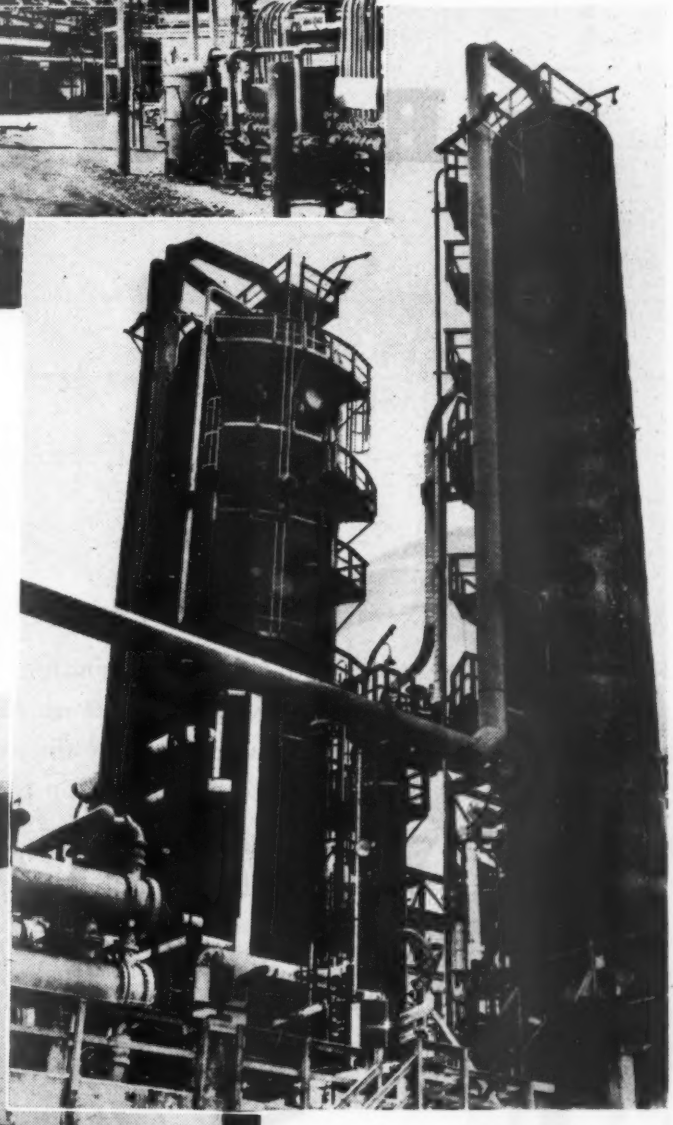


Each of the large catalyst cases in this view of the plant contains more than a thousand concentric tubes. Space around the tubes is packed with small catalyst pellets.

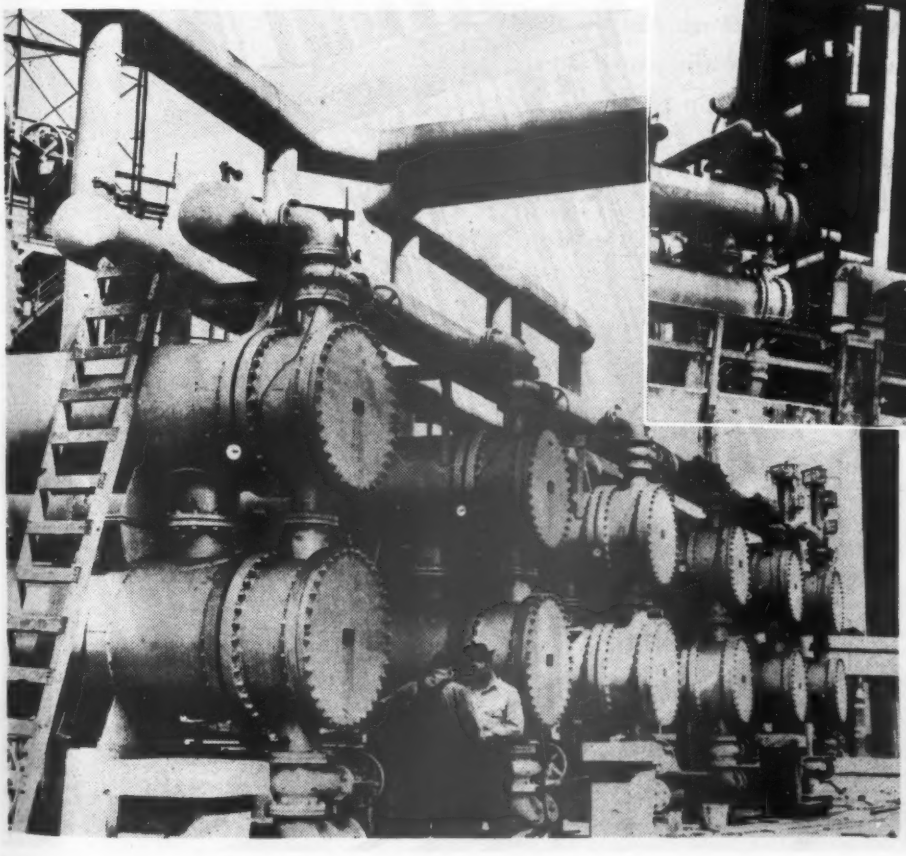
attached to the upper manifold. A single cycle timer automatically opens and shuts the motor valves so that each pair of cases has an on-stream period of ten minutes.

The oil vapors from the catalyst cases enter the base of the 18 ft. diameter cracking synthetic crude tower where they are de-superheated by circulating bottoms through the fresh feed exchangers. In this fractionator, first pass aviation base is taken overhead, a light catalytic gas oil is withdrawn as a side stream, and a small percentage of heavy catalytic gas oil is taken from the bottom.

The light catalytic gas oil is stripped with steam in a bubble tray stripper, heat exchanged with the fresh feed, and then cooled. Various uses are made of this stream such as lean oil, furnace oil, and thermal cracking stock.



Oil vapors from the catalyst cases enter the base of the fractionating towers, *above*, where they are de-superheated by circulating bottoms through the fresh feed exchangers.



Synthetic tower overhead goes to the condensers, *left*, then to gas-water separator.

Badger vacuum units produce

Specification products

Badger engineers pioneered in the introduction of precise fractionation methods to the petroleum industry, and the design of *vacuum distillation* units for the production of high flash, low carbon-residue lubricating oil streams has long been a Badger specialty.

Badger also pioneered in the application of its distillation experience to the simultaneous decolorizing and separation by fractionation of lube oils to the several classes of finished products desired. Particularly applicable where a residual stock is being processed, Badger-built *FILTROL FRACTIONATION UNITS* are daily turning in outstanding performances.

FURFURAL EXTRACTION and *MEK DEWAXING* processes are offered by Badger under appropriate licenses.

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PROCESS ENGINEERS AND CONSTRUCTORS FOR THE PETROLEUM, PETRO-CHEMICAL AND CHEMICAL INDUSTRIES
LICENSING AGENTS FOR THE HOUDRY CATALYTIC CRACKING PROCESSES AND THE TCC PROCESS

The synthetic tower overhead goes to the condensers and then to a gas-water separator where the condensed steam is automatically released to the sewer. The non-condensed gases flow to 300 hp. gas engine driven two-stage compressors equipped with intercoolers and knock out drums. The fuel gas to these engines is treated in a Girbotol unit to remove the corrosive hydrogen sulphide. To provide the surge capacity needed in the process, large gas holders float on this suction line thereby providing constant flow to the gas plant area. The non-condensed gas, the liquid condensate from the compressors, and the liquid from the separator, after passing through a cooler, are blended in a contractor to establish good gas-liquid equilibrium. The resulting gases move to a 3 by 77 ft., 32 tray, absorber where the lean oil recovers the valuable butanes and returns them to the synthetic tower. The non-absorbed dry gases are released to the refinery fuel gas system from the top of this tower.

The unstabilized first-pass base from the bottom of the contactor drops to the depropanizer feed drum. The discharge rate of the centrifugal feed pumps to the depropanizer bottoms-feed exchangers is regulated by a manually set recording flow controller mounted in the gas plant control house. The heated feed enters the 6 ft., 6 in., 34 tray, depropanizing tower where propane and lighter gases are released from the overhead accumulator to the fuel gas system. The operating pressure of this tower, 300 lb., is maintained by controlling the water from the overhead condenser. The total bottoms from the last tray is heated to 350° F. in a siphon-type reboiler by 450 lb. steam before re-entering the base of the tower.

A liquid level controller determines the rate of release of the depropanizer bottoms from the feed exchangers to the 85 lb. 6 ft., 6 in., 34 tray, 100 ft. high debutanizer tower. A mixed B-B cut, containing over 55 per cent isobutane, is taken overhead and pumped to alyklate feed storage tanks. The stabilized first-pass base is pumped from the kettle-type reboiler through a cooler to the treater feed storage tanks. The live steam to the reboiler is controlled by a temperature controller actuated by the temperature on the No. 6 tray, which adjusts for small variations in the feed rate and composition.

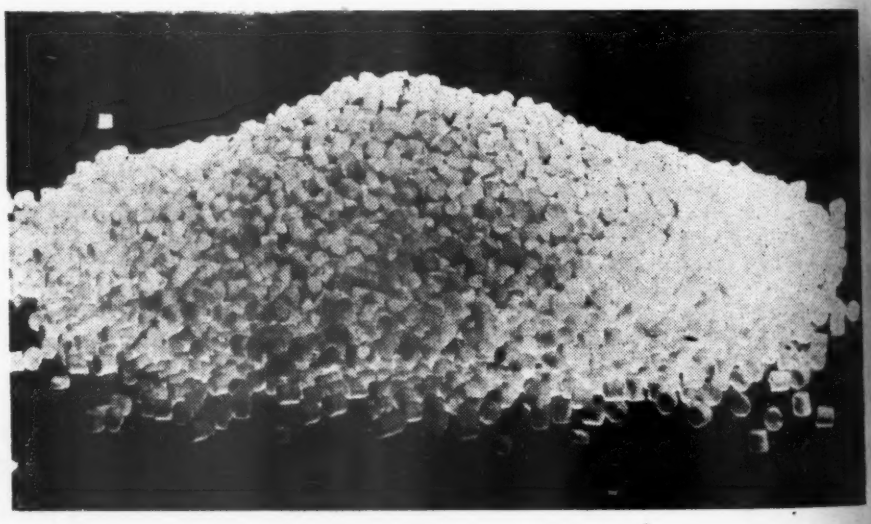
Treater feed centrifugal pumps force the first-pass base through heat exchangers and into a single pass furnace built similar to the cracking heater. The vapors then go through the treating cases and to the treater synthetic crude tower where they are also desuperheated by circulated tower bottoms. Aviation base stock is taken overhead from this 10 ft. 6 in. bubble tower. A narrow boiling range catalytic motor naphtha is transferred to a stripper from part way up the tower, while the polymer gas oil bottoms go to fuel oil by way of a steam stripper.

The overhead vapors travel in a similar path as those from the other synthetic tower, namely condensers, gas-water separator, gas holder, compressors, cooler, and contactor. The gases from the treating contactor join those from the cracking contactor on their way

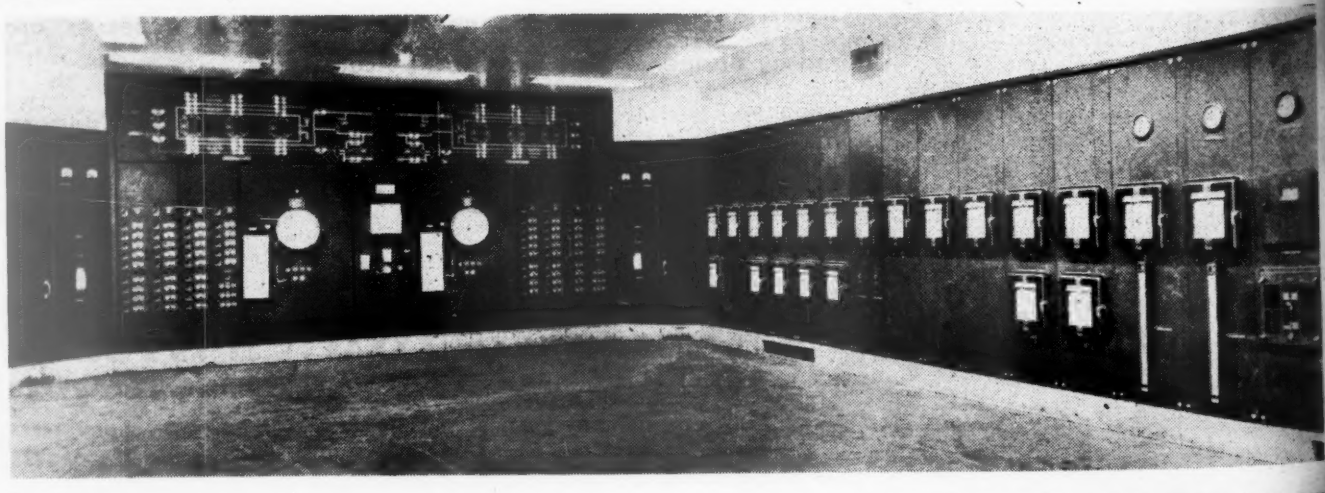
TABLE I

Typical Inspections of Charge and Products, Sohio Houdry Fixed-Bed Catalytic Cracking Plant, Cleveland, Ohio.

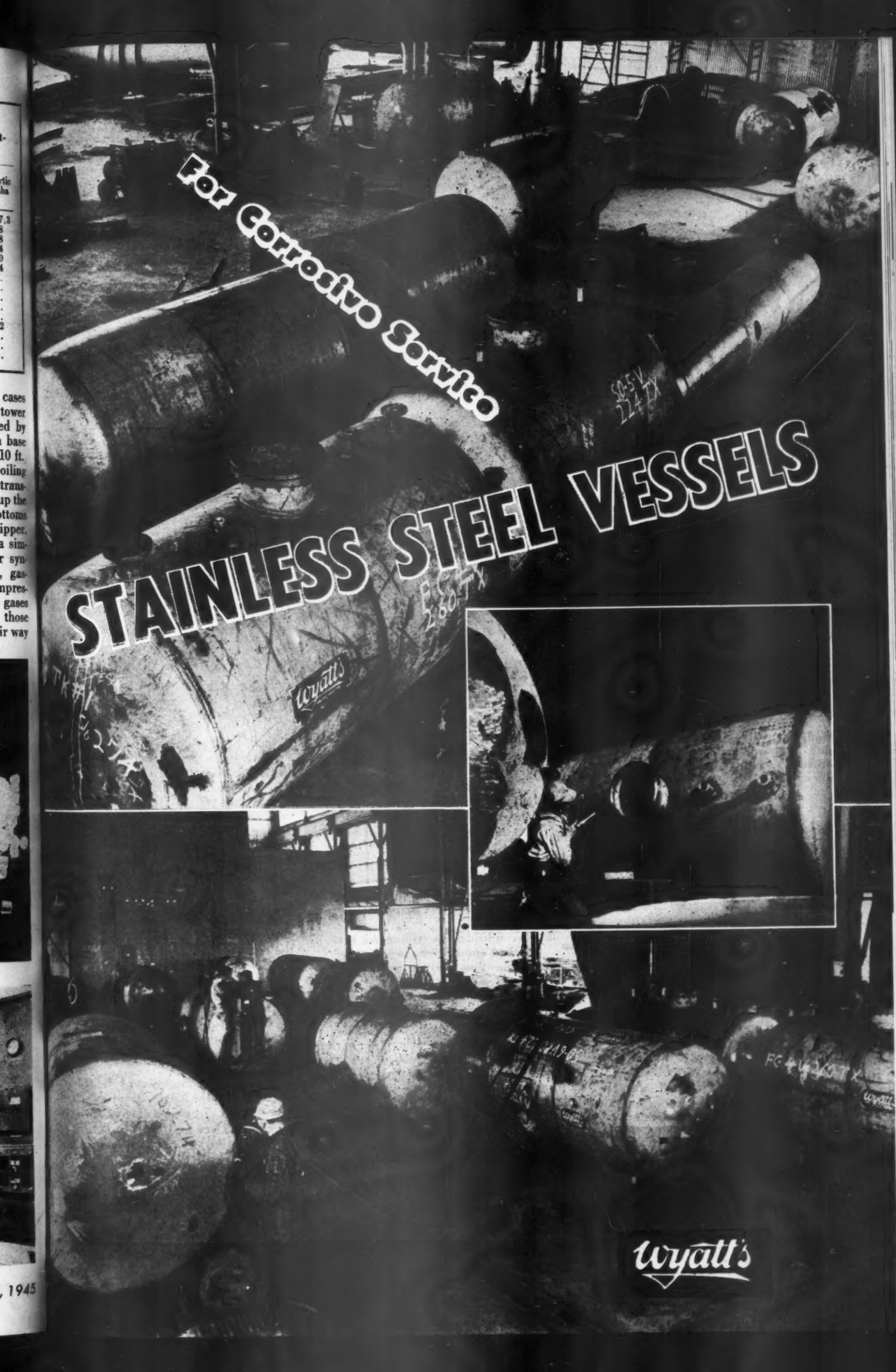
	Mixed G.O. charge	Catalytic heavy G. O.	Catalytic light G. O.	First pass base	Poly gas oil	Second pass base	Catalytic naphtha
°API	29.8	21.6	31.6	53.3	27.9	63.1	37.3
IBP	428	624	456	100	360	106	338
10	494	678	510	128	428	132	348
50	634	..	545	280	456	188	364
90	..	..	616	420	552	292	390
EP	..	..	660	448	672	334	414
Per cent at 70° F.	66	29	..	..	..	..	..
SSU at 100 °F.	63	123	39	..	33	..	..
122 °F.	48	85	36	..	32	..	..
Pour, °F.	65	80	20	..	95+	..	..
CFR-R (3)	..	..	..	91.2	..	97.9	..
Acid heat, °F.	..	34	24	88	35.5	12	2
Aniline point	179	182	148	..	96	..	..
P. M. flash	230	230+	230	..	178	..	..
C.O.C. flash	235	370	235	..	180	..	..



Clay-like catalyst pellets used in the Sohio unit.



Vital information from every corner of the plant pours into this control room, which is lined with recording, controlling, and indicating instruments.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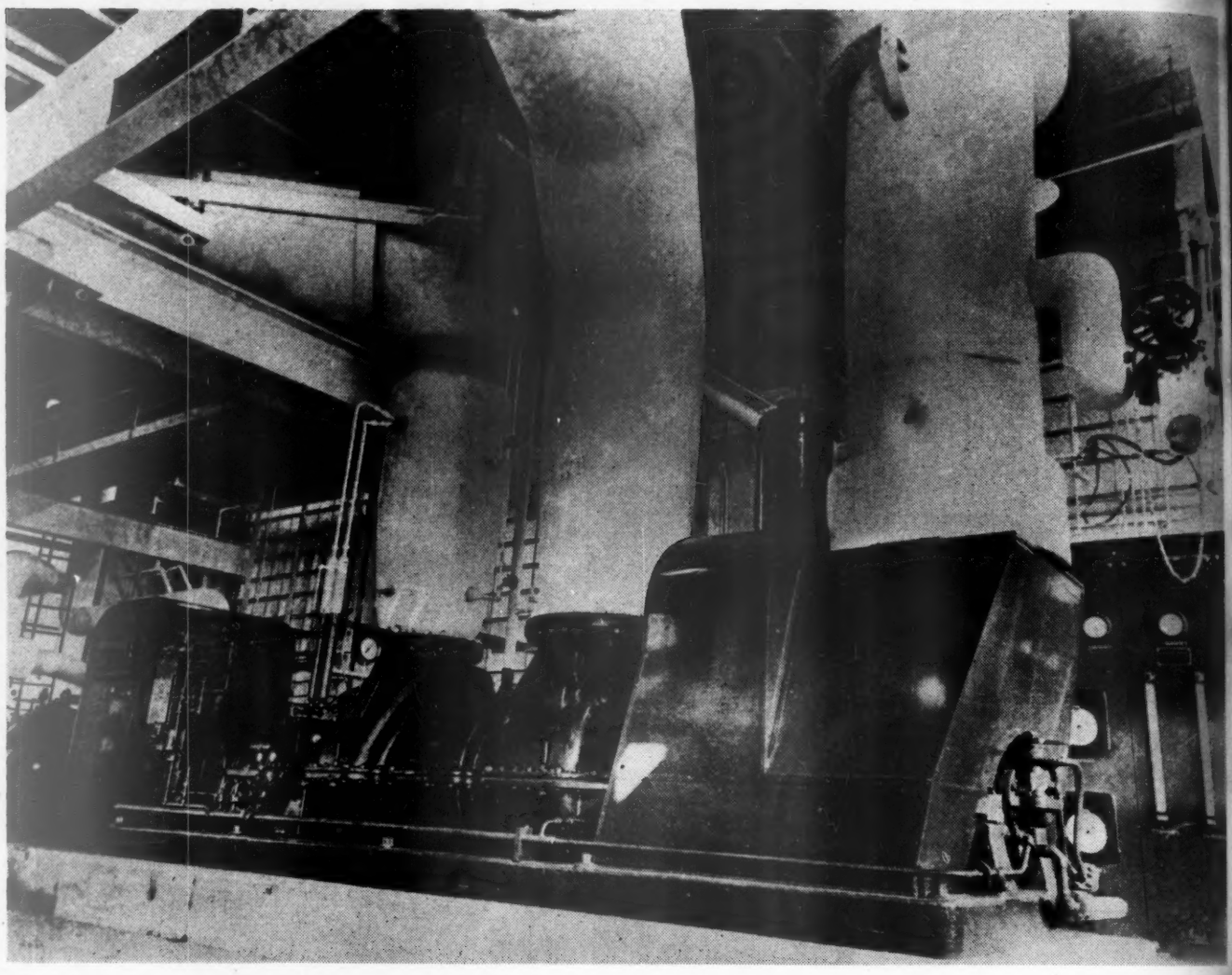


Modern gas turbine-axial compressors supply compressed air used during the regeneration part of the cycle.

to the common absorber. The wild second pass base is pumped to an 80 ft. stabilizing tower from which the finished aviation base flows to storage ready for blending into high-octane aviation gasoline. The condensed stabilizer overhead is released to a 3 ft., 6 in. splitting tower where the butanes are separated from the isopentane bottoms. These two streams are then pumped to their respective storage facilities.

● **Catalyst cases.** The catalyst cases are large 12 ft. by 33 ft. drums each containing over a thousand concentric tubes equipped with external heat transferring fins. The space around and between these tubes is packed with small catalyst pellets. One group of tubes distributes alternately the inlet oil vapors and the inlet air used for burning off the carbon deposit on the catalyst. Another cluster of tubes lead the catalyzed oil vapors and regeneration gases to the outlet headers. The third set of tubes, intermingled with the two already mentioned, supply the necessary heat for catalyzing the oil vapors and removing the heat generated when burning off the carbon deposit. The cooling-heating medium circulated through these latter tubes is a eutectic mixture of fusible salts.

The cycle of operations for each case requires approximately a half hour divided as follows:

a. **Ten minutes on stream while the oil vapors are being contacted with the catalyst.**
b. **Five minutes for removing and purging the oil vapors in preparation for regeneration.**
c. **Ten minutes for regeneration period.**
d. **Five minutes for removing the air and combustion products in preparation for the return of the oil vapors.**

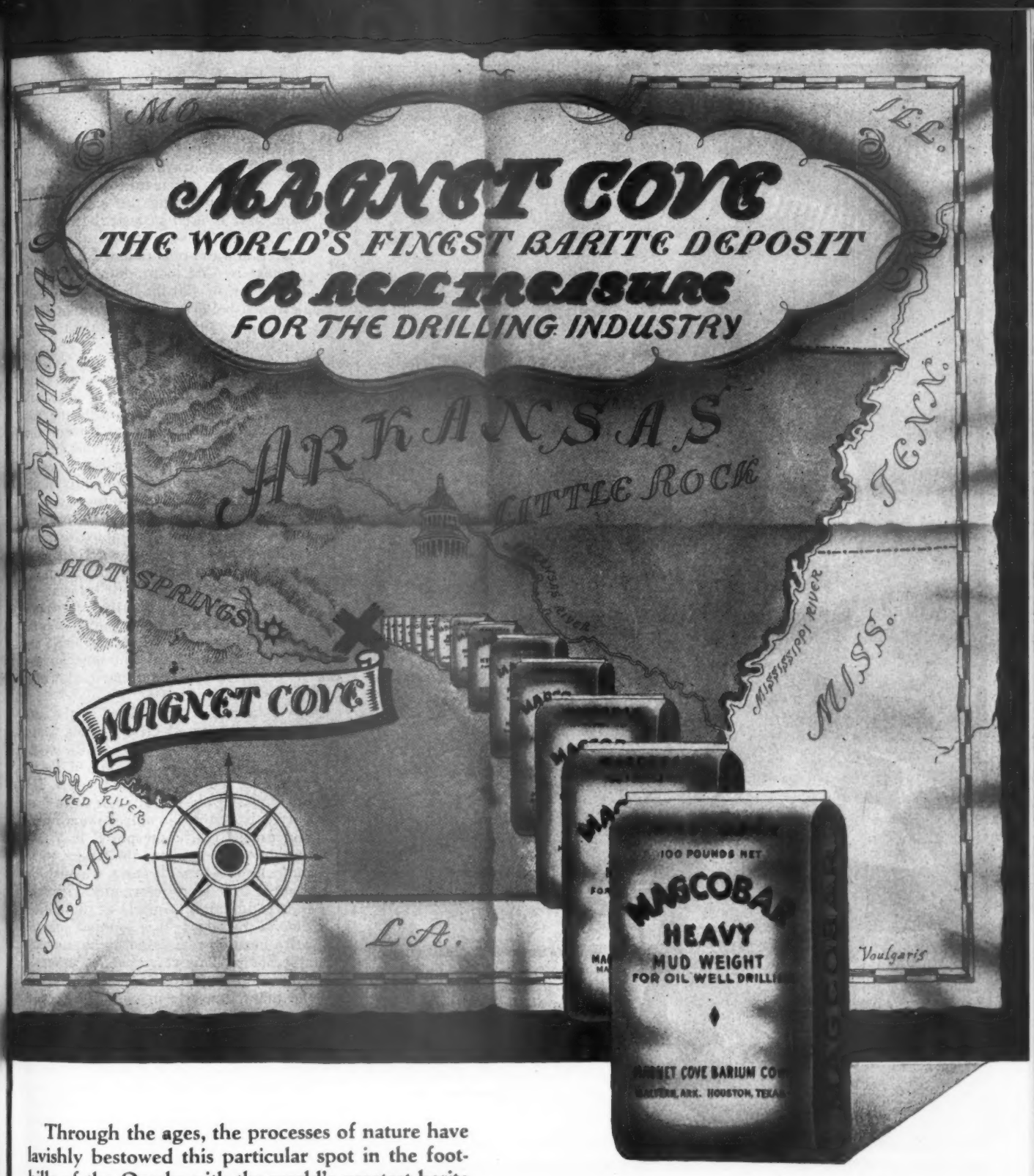
The need for removing hot oil vapors before injecting hot air, and the converse, is necessary to prevent any back firing.

The oil-stream vapors remaining in the cases after the on-stream period are sucked out by large steam ejectors through a 72 in. barometric precondenser. The condensed oil and steam, together with the cooling water, drop down through the tail pipes to a seal tank from which the oil is continuously decanted, settled, and returned to the synthetic tower. The 6000 gal. per min. barometric pumps return the water from the seal tanks to an induced-draft cooling tower for re-use.

The compressed air used during the regeneration part of the cycle is furnished by a modern gas turbine-axial compressor which is coupled to an induction type motor-generator and a starting steam turbine. Outside air is drawn through an oil filter by the rotary compressor and forced through a heat exchanger to the cases. The temperature of the air is raised enough to burn off rapidly the carbon on the catalysts by circulating molten salt in the heat exchanger tubes. From the cases the hot gases of combustion expand through the gas turbine and thence to a 120 ft. brick stack. The average power developed by the turbine is greater than that required by the compressor and the excess energy is supplied to the generator. The generator acts as a stabilizer for the rest of this motive-equipment acting as a motor if the speed drops and as a generator when it tends to increase. The combined horsepower of the cracking and treating turbo units is 10,255.

When the regeneration of the catalyst is complete, the cases are blocked off from the air circuit by closing the proper motor valves and the pressure is released directly to the atmosphere. The residual air is then evacuated by a single-stage ejector exhausting through a muffler to the air.

Large vertical turbine-type, motor-driven pumps immersed in the 14 ft. diameter by 60 ft. molten salt tanks continuously circulate a million and a half



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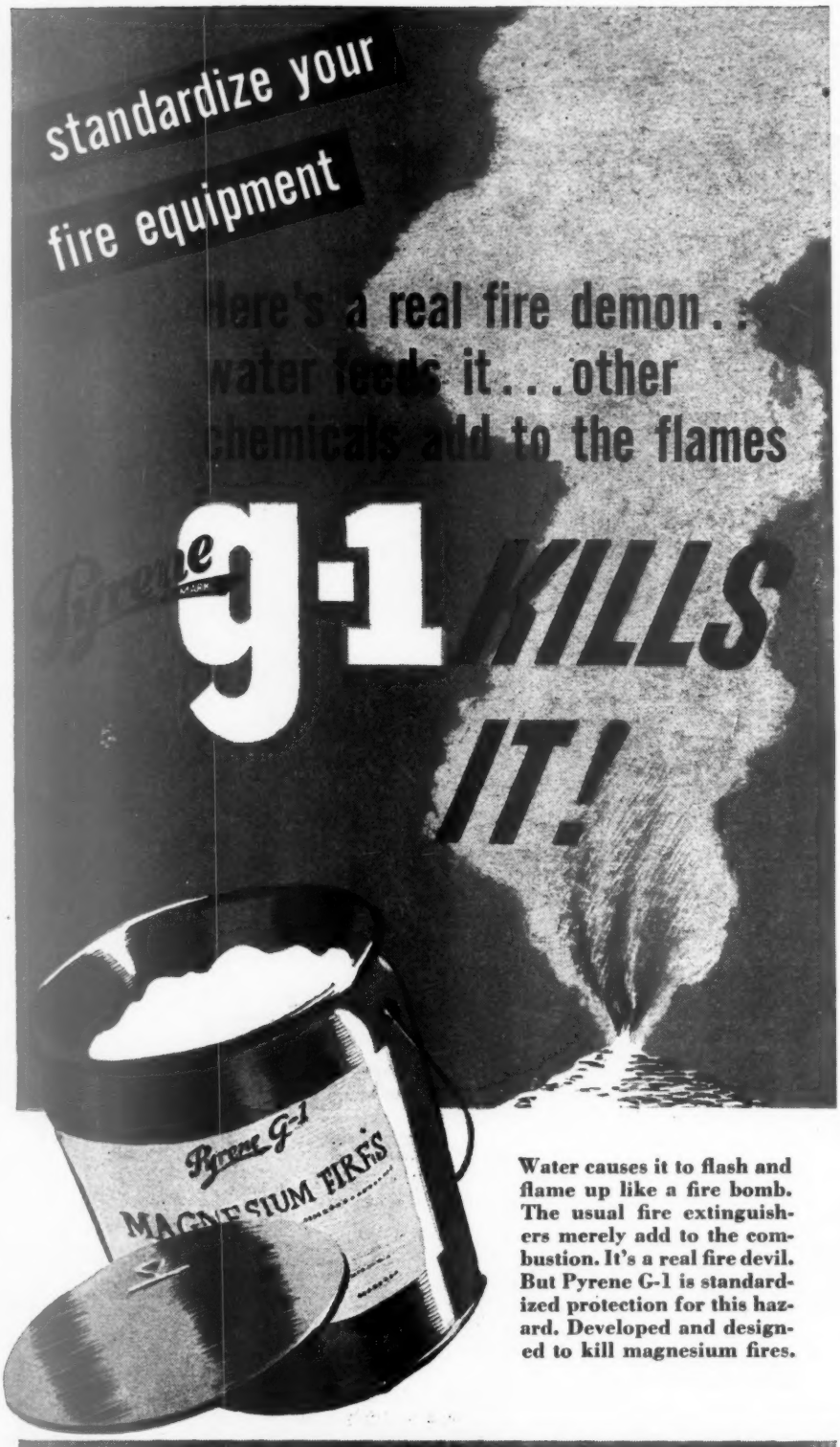

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pounds of the dual purpose heating-cooling medium through the cases, air heaters, and salt boilers.

The exothermic heat released by the burning of the carbon deposit on the catalyst is absorbed by the salt. Part of this energy is given up to the endothermic reaction during the on-stream period, part is used to heat the regeneration air as it passes through the salt air heater, and the remainder of the absorbed heat is used to produce over 80,000 lb. per hr. of 450 lb. steam in specially designed boilers. The salt system of the treating section is independent of the one in the cracking section.

● **Control room.** The main control room, situated at the center of the unit, is lined on each side with recording, controlling, and indicating instruments that reveal to the operators all the vital information needed to run this complex equipment. Located prominently at one end of the main control room are the two cycle timers which run the catalysis cases on their rigid time table. No hydrocarbon liquids or vapors enter this room as all measurements are transmitted either electrically or by air transmission from the indicating instruments scattered at the vital measuring points over the unit. To further preclude explosive and corrosive vapors and eliminate the need of explosive type equipment, the room is pressure ventilated.

The impulses transmitted by the cycle timers activate electric motors which open and close the case valves at the proper intervals as determined by the operating sequence of the process. This opening and closing of each valve is reported back to the control room by red and green lights, interposed in a schematic flow sheet above the timers, which indicate to the operators whether the plant is functioning normally. If a valve fails to function properly at the desired time, a warning bell is sounded and the valve location registered on an annunciator board. This valve can be operated by pushing a button situated alongside the timer that sets in motion a secondary system of control. If any valve still fails to operate, or if any other trouble develops, the catalyst cases may be bypassed quickly by button operation of the motor operated block and bypass valves without shutting down the whole plant. The timer is run by a synchronous motor that has contacts for 900 impulses in one complete revolution, which corresponds to one complete case cycle.

In case of power failure, a magnetic closed steam block valve opens and admits steam to the turbine of an emergency electrical generator. Sufficient current is then produced to operate the timer, the motor valves, and emergency lighting circuits. As an additional safety device, a 24 in. safety flare rises over 200 ft. in the air for use when quick release of gases is necessary in case of trouble.

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THE FLUOR PULSATION DAMPENER tunes out vibrations caused by pulsative flow in pipe lines, ducts or related equipment carrying air, vapors or gases by converting the pulsative flow into a steady stream. Whenever a pulsative flow exists, there is usually some portion of the piping or duct system which has a natural frequency in tune with either the fundamental pulsation frequency or one of its harmonics. By eliminating the pulsations in the flow, the vibrations originated by them are literally tuned out. Thus, the Fluor Pulsation Dampener stops vibration by eliminating the cause.

Patents Applied For

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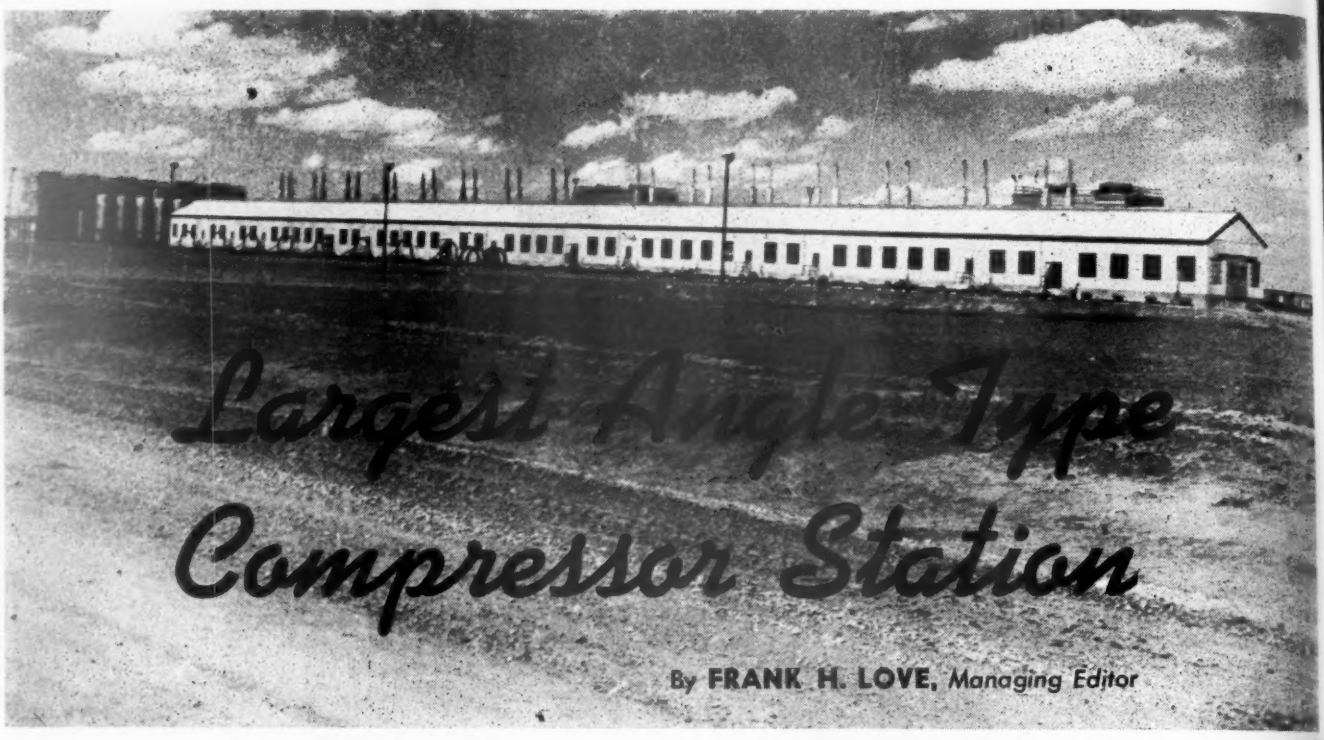

Largest Angle Type Compressor Station

By FRANK H. LOVE, *Managing Editor*

View of building that houses fifteen 1000-hp. compressor units, with cooling tower shown in background

EXCLUSIVE CITIES SERVICE TRANSPORTATION and Chemical Company has recently completed the installation of the greatest number of angle type compressors ever assembled by a gas pipe line company under one roof. The installation at Guymon, Oklahoma, known as the H. R. Straight Compressor Station, consists of fifteen 10-cylinder units each rated at 1000 b. hp. at 300 r.p.m., sea level. The compressor plant pumps natural gas from the Hugoton field, largest known reservoir of natural gas in the world, through 230 miles of 26-in. welded line to Blackwell, Oklahoma, where it connects with the Cities Service Gas Company system that carries gas east and north to serve eastern Kansas, western Missouri, and northeastern Oklahoma.

The compressor plant installation, actually, was a two-program affair. When the station was first placed in operation in May, 1944, there were eight units. The second half of the program saw seven additional units installed, these going into operation the early part of 1945. Nominal capacity of the line now is 220,000,000 cu. ft. a day, with the compressors operating at a suction pressure of 350 lb. per sq. in. gage and a discharge pressure of 775 lb. per sq. in. gage.

Two gathering systems, one serving the north end of the field and the other the south, bring gas to the plant from a total of 94 wells that were drilled by the Cities Service Gas Company. The main line into the plant from the field is of 20 in. diam. Upon arrival at the plant the gas is first passed through four dust scrubbers each of which has a capacity of 55,000,000 cu. ft. of gas a day and is designed for a working pressure of 500 lb. These units are 5 ft. in diam., by 18 ft. high.

From the scrubbers the gas enters a 26-in. header, which is below ground. Compressor intake lines off this header are of 8-in. pipe. Each compressor unit is equipped with three 8-in. by 14-in. double-acting, liner-type, cast compressor cylinders. Each cylinder, also, has a clearance valve and a clearance extension bottle. The engines are equipped with silencers on the exhaust and combustion air is drawn through oilbath type filters.

When the gas leaves the compressors it enters a 26-in. header that parallels the 26-in. intake header, then passes through atmospheric cooling coils, there being 14 of these sections in two cooling towers. From the cooling sections the gas enters another 26-in. header and is discharged into the top of activated bauxite dehydrators. After passing downward through the dehydrators and being stripped of moisture the dry gas leaves at the bottom of the vessel and enters the 26-in. main line.

Fifteen 10-cylinder units installed under one roof pump gas from Hugoton field to Blackwell, Oklahoma.

● **Dehydration.** The dehydrator battery consists of six units. Four of these operate in parallel to remove moisture from the gas; the other two are to regenerate the bauxite. Regeneration gas is taken off the hot discharge header and passed into a heater that has a capacity of 22,000,000 cu. ft. a day. The temperature of the gas is raised to 350-400°F. after which it is passed through the dehydrators, flowing from the bottom of the vessels upward. The hot gas dries out the bauxite bed, returning it to its previous state of dryness. The gas then goes through five atmospheric sections and is cooled down to the same temperature as the gas from the compressor discharge. After passing through a 36-in. diam. by 18-ft. high scrubber where condensate is trapped out it enters the 26-in. main line along with the rest of the commercial gas.

Procedure is to operate four dehydrators on stream and two regenerating. Every eight hours two of the dehydrators on stream are taken off and put on the regenerating cycle. Thus each unit operates 16 hours on stream and 8 hours regenerating. When regenerating, the rate of gas flow through the dehydrators is roughly 10 per cent of the rate of flow during dehydration.

The dehydrators are insulated internally, which effects a saving both in time and fuel because it is thus unnecessary to heat up the shell each time the bauxite is regenerated.

● **Jacket water system.** The jacket water intake header is situated in the basement of the compressor building. Operating in parallel, the pumps take water from this header and discharge into a common header from which the water enters the engine jackets. From the engine jackets the water enters a

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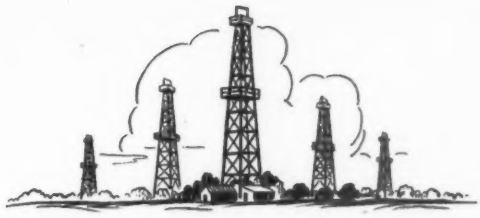


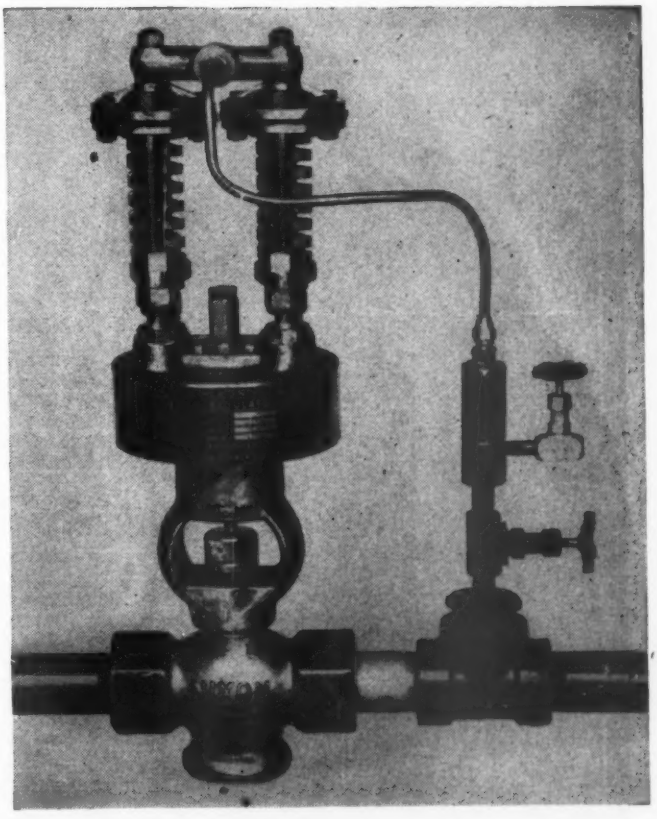
There are many applications for the Nixon "selective flow differential" REGULATOR

(a) on high pressure lines in regular pressure reduction work.

(b) on high pressure separators as back pressure valves.

(c) on flow lines from gas wells which make fluid.

(d) as a safety valve on flow lines from high pressure oil wells.



The NIXON REGULATOR is "tomorrow's" Regulator . . . available to the industry NOW. It has proven its superior performance qualities under varied and most severe conditions. If you want a Regulator that really "Regulates" get a NIXON REGULATOR.

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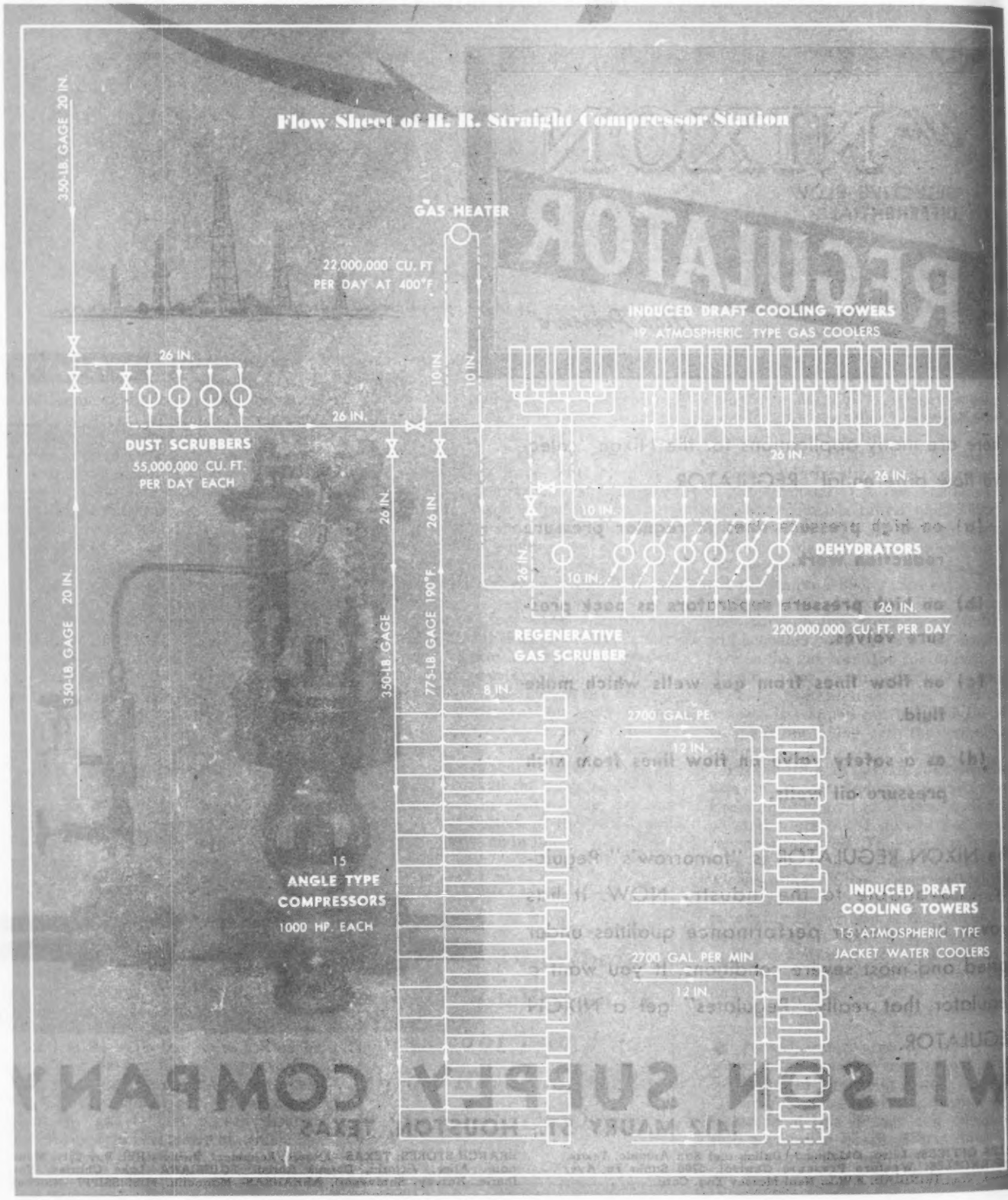
third header. All headers are 10 in. in diam. and are situated in the basement of the compressor building. From the last header the flow is through two lines to atmospheric sections in the cooling tower. From the tower the water flows to a surge tank then enters the first header to begin another cycle.

There are two systems of the type described, one serving the first eight units installed, the other the seven units installed and placed in operation the early part of 1945.

Circulating pumps consist of eight motor-driven centrifugals split vertically.

● **Plant heating.** The same water that cools the engine jackets is used in a system to heat the compressor building. In the basement are situated 16 unit heaters. Water from the engine jackets is passed directly through these heaters and back into the intake header of the jacket water system. While flowing through the heaters the water heats air that is drawn into the heater from the outside by an intake through the building wall. The heated air is discharged to the operating floor through ducts and grilles. A hot water boiler has been provided as a standby that can be used to heat the water for this system should the need arise.

● **Engine lube oil coolers.** Each engine has its individual lube oil cooler. These are shell-and-tube type coolers, which are situated in the basement. A lateral line comes off the discharge of the cooling tower water circulating



ALIGNMENT HEADACHES?

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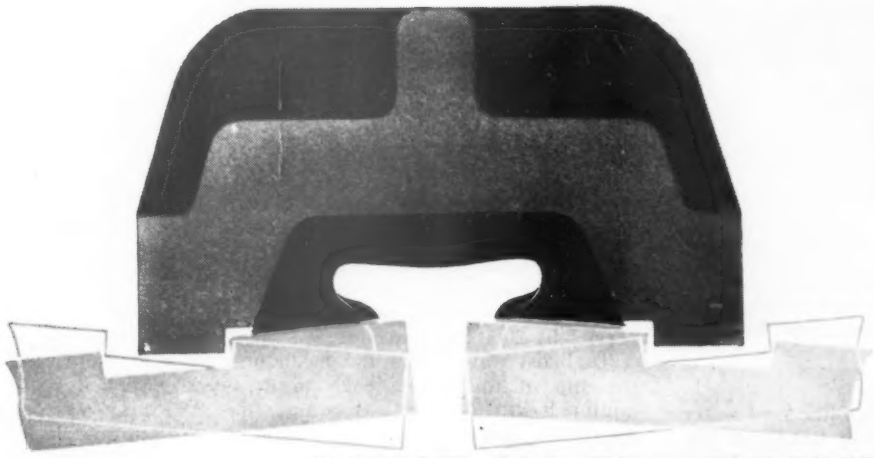

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SELF-ALIGNING PIPE COUPLINGS AND FULL-FLOW FITTINGS

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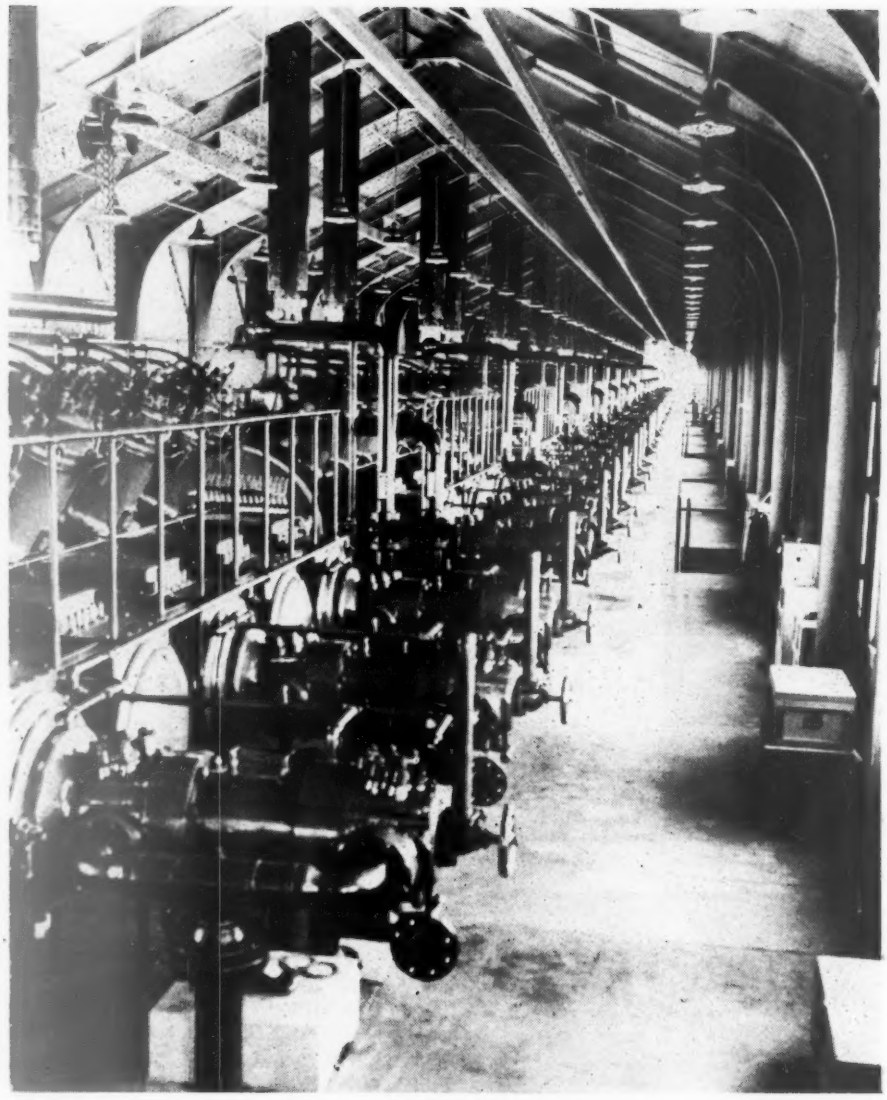
OIL MINING MARINE MUNICIPAL INDUSTRIAL



The 15 compressor units have a rating of 1000 b.hp. each at 300 r.p.m., sea level. Gas is compressed and boosted through 230 miles of 26-in. pipe line.

pumps and through this line cool water is discharged into a 6-in. header in the basement of the compressor building. From this header water flows through the lube oil coolers and into a second header, from which header two lines return the water to the cooling tower basin. Each cooler handles 180 gal. per min. of oil, cooling it from 150°F. to 132°F.

● **Gas cooling.** To cool the gas a system has been provided identical with that utilized for cooling jacket water.

● **Cooling towers.** All cooling towers are of the induced draft type. The tower originally provided for cooling jacket water has a capacity of 3000 gal. per min., cooling water from 108°F. to 84°F. with a wet bulb of 70 and relative humidity of 60 per cent. When the additions to the plant were made this tower was duplicated.

The original gas cooling tower has a capacity of 2800 gal. per min., cooling from 100°F. to 80°F. with a wet bulb of 70 and relative humidity of 60 per cent. An additional cooling tower installed and placed in operation the first of the year increased capacity for this service by 2000 gal. per min.

To boost water from the basin over the top of the tower, each tower is equipped with two vertical pumps, motor driven, one being used as a standby unit.

● **Water supply.** To provide makeup water to the cooling towers three wells were drilled, each having a capacity of 300 gal. per min. and equipped with motor drive. In addition, one well has both a motor drive and a gas engine drive for emergency use should the electric power be off for any reason. Water from the wells is discharged into a common header with a relief valve into each tower.

● **Electric power.** Electric power is purchased commercially. The power comes into the plant on a looped line at 33,000 volts, is stepped down at a substation to 4000 volts, and reduced to 440 volts by a transformer bank at the compressor building. This power is used to drive motors and for plant and cottage lighting. All power wiring with switches, circuit breakers, etc., meet Class 1 Group D standards, as do all motors in hazardous areas.

A 75-kw. generator serves as standby for electric power.

● **Engine ignition.** The engines are equipped with battery ignition. The central unit consists of two rectifiers and two batteries, of which only one is required for normal operation, the other being used as a standby. Ignition current is delivered to buses on the compressors, and each compressor is equipped with an ammeter and a fuse switch.

● **Compressor building.** The main compressor building has an overall length of 582 ft., is 30 ft. wide and 14 ft. high. Construction is of corrugated asbestos with arch type trusses and a full basement. In one end of the building is situated the machine shop and in the basement immediately below the machine shop are the standby heating boiler, standby generator, starting air compressors, and electric power entrance switches and breakers. Also, on the main floor, three crane rails have been provided to move engine parts in overhauling.

● **Meters.** Gas is metered at each well and also at the main line discharge.

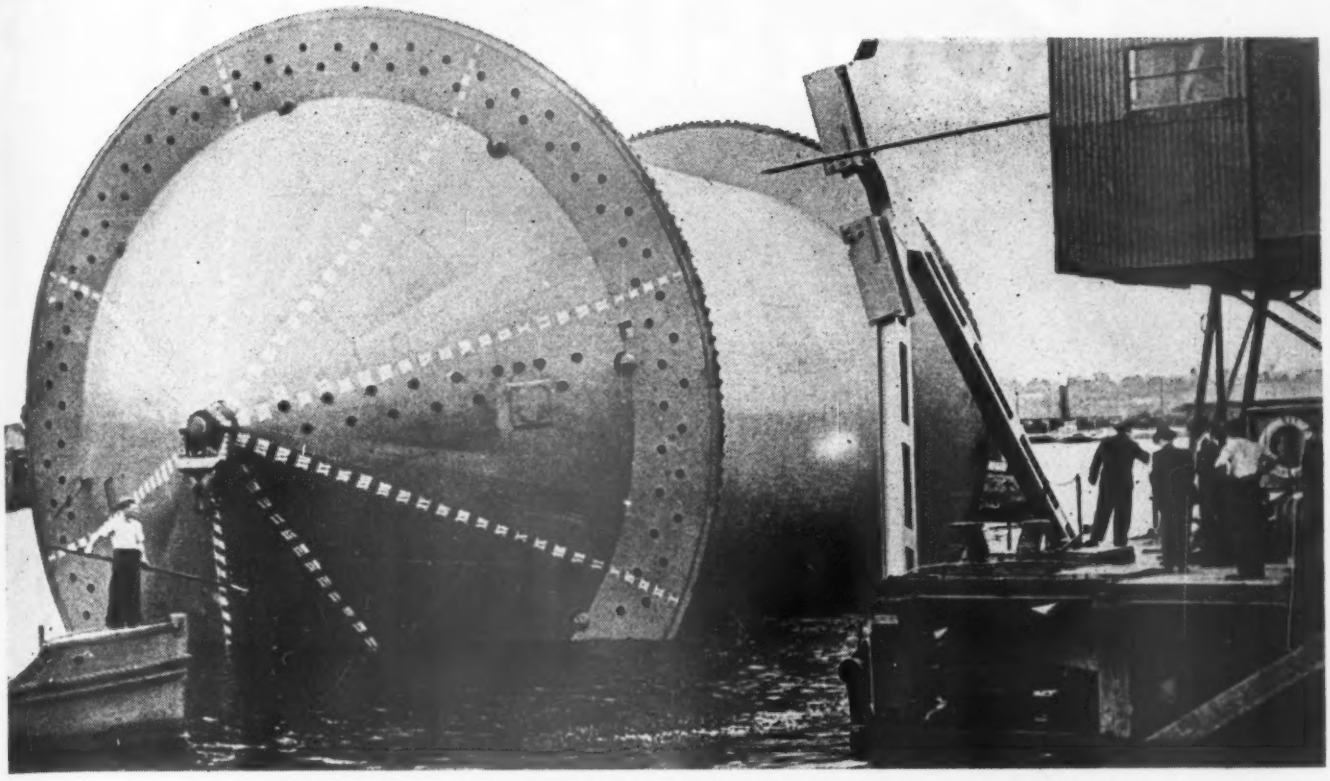
● **Pressure vessels and piping.** All pressure vessels were designed in accordance with the API-ASME Code. Piping was designed equal to or better than Section 2 Division 2 of the American Standard Code for Pressure Piping.

● **Office and houses.** Sixty houses on the plant site, a small village within itself, houses station operators, as well as personnel of the production department and operators of the gathering and main line systems in the area. ★★★

First exports from Iraq concessions by next year

First shipments of oil from the Kuwait fields in Iraq on the Persian Gulf will be made in the first quarter of next year, according to an announcement by J. F. Drake, president of Gulf Oil Corporation. The Iraq field is considered by geologists as potentially one of the world's major petroleum reserves. Gulf shares ownership of the Kuwait concession with Britain's Anglo-Iranian Oil Company, Ltd.

No shipments of Kuwait oil have been made to commercial markets since acquisition of the concession at the head of the Persian Gulf 11 years ago. Nine wells, however, have been completed and work on the tenth was suspended because of the war.



A Conun-drum being moved into position for loading steel pipe to be used for the pipe-line system under the English Channel that fed the Anglo-American armies gasoline in the European war. The gigantic seagoing "bobbins" were towed by the Royal Navy across the Channel to lay continuous lengths of pipe 70 miles long. When fully loaded they carried 1600 tons, the weight of a destroyer. The Conun-drums were moored in deep water at the end of the pipe racks; the pipe welded into a continuous length and wound onto them.

"Operation Pluto", The Story of the Channel Pipe Line

FROM August 12, 1944, to May 8, 1945, about 120,000,000 gal. of gasoline reached the Anglo-American armies in Europe via the pipe-line system laid under the English Channel by British engineers in cooperation with the British Navy. One million gallons daily still reach France by way of 20 undersea pipe lines. Sixteen of these extend from Dungeness, on the southeast coast of England, to Boulogne and 4 from the Isle of Wight to Cherbourg, and are thence carried via high pressure gasoline lines to the Rhine. This vast engineering feat was called "Operation Pluto," meaning "Pipe Line Under the Ocean," and guaranteed uninterrupted delivery of bulk petroleum, usually needing a special harbor and dock and extensive storage facilities, across the beaches, making it invulnerable from air, surface or submarine attack, and completely independent of the weather.

While the British Pluto project was under way, the United States Army was working on a similar idea. After discussions between the respective authorities, it was agreed that efforts should be concentrated on Pluto, and United States authorities magnanimously cooperated fully in many directions. General Eisenhower and his chief officers took an active interest in Pluto's development, and a unit of the United States Army Engineers Corps, under the direction of Colonel A. K. Easton, New York, arranged for the manufacture of 140 miles of HAIS cable by the General Cable Company, Phelps Dodge Copper Products Corporation, the General Electric Company, and the Okonite Callender Cable Company. With the exception of the 140 miles of cable manufactured in the United States, the Channel pipe line was a purely British operation in plan and execution.

It was Lord Louis Mountbatten, then head of Combined Operations, who in April, 1942, asked Geoffrey Lloyd, British Minister of Petroleum Warfare, whether an oil pipe line could be laid across the English Channel. The experts were doubtful, but A. C. Hartley, chief engineer of the Anglo-Iranian Oil Company, who had used 3-in. high pressure pipe lines in Persia, suggested a pipe line something like a submarine electric power cable without cores and insulation, which could be laid across the Channel in a few hours from cable-laying ships.

Details are now given of how pipe line was laid on bottom of English Channel to supply armed forces.

By working day and night over two week-ends, technicians of the firm of Siemens and Henleys completed the full-scale order for several hundreds of yards of this pipe line to be laid in the Thames from a cable-ship loaned by the British Post Office. The results were so successful that Prime Minister Churchill gave the plan his blessing and two 30-mile lengths of cable were ordered to the original 2-in. diameter, so that full-scale trials could be made in the Bristol Channel, where the currents and other conditions approximated most closely to those found in the English Channel. Subsequently, the cable diameters were increased to 3 in. and strengthened for working pressures in excess of 1200 lb. per sq. in. Eight months after Hartley's idea originated, when half a gale was blowing in Bristol Channel, the experimental cable was laid by H.M.S. Hold-

(Continued on Page 170)

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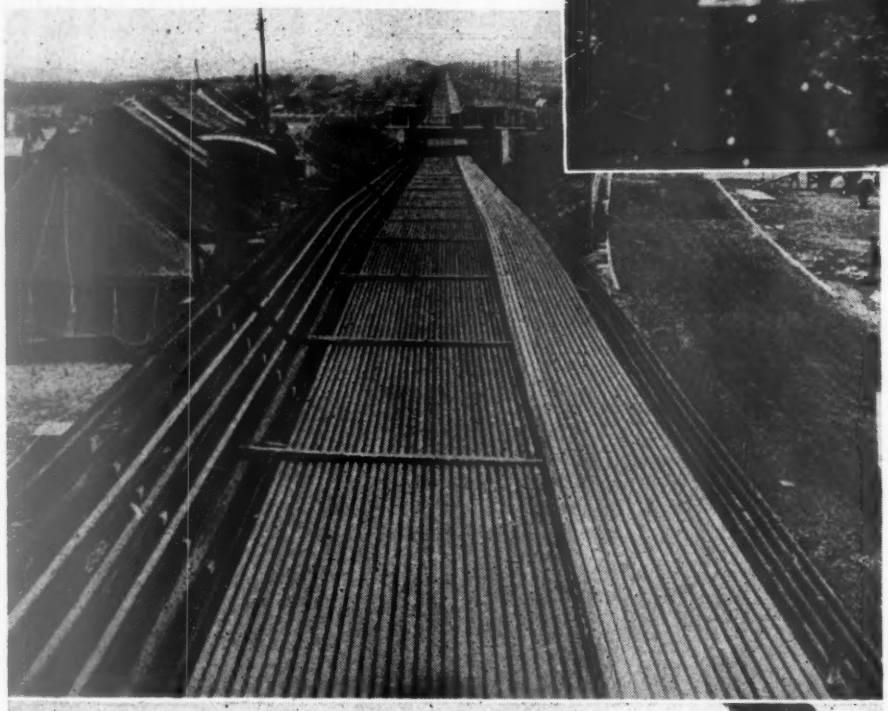
Right—**Method of camouflaging pipes leading from gasoline storage tank in Europe as the fuel was carried through to the front lines.**

Below—**Hamel pipe stored in ¾-mile lengths ready for winding on the Conun-drums. About 200 miles of pipe can be seen in this picture.**

Bottom—**British troops installing the T-union valve at Boulogne for the first pipe line in October, 1944. By means of the pipe-line network in Britain gasoline was pumped from Liverpool through to Frankfort-on-Main with big savings of tankage and truckage.**



(Continued from Page 167)

fast, originally a coaster that had been fitted with gear for transporting this unusually heavy cable, and gasoline was delivered from Swansea to Ilfracombe. The fact that the cable was hollow increased the difficulties, for it was likely to kink and so stop the oil flow. The cables were therefore laid full of water, which kept them inflated. This pipe line was called the HAIS (Hartley-Anglo-Iranian-Siemens).

Meanwhile another pipe line was designed by B. J. Ellis, chief oilfields engineer of the Burma Oil Company, and H. A. Hammick, chief engineer of the Iraq Petroleum Company. This second pipe line, named "Hamel," was composed of 20-ft. lengths of 3-in. diameter steel pipe that could be welded automatically into any length and could be wound onto a drum like thread on a spool, if the drum were 30 ft. or more in diameter. To use this, the admiralty's director of naval construction designed H.M.S. Persephone, converted from a hopper barge to a craft with a great wheel rotating in trunnions on her deck and capable of carrying many miles of the 3-in. Hamel pipe and paying it into the sea. From this a second idea was developed, a floating drum capable of carrying the full length of pipe that might be required for the Channel crossing, and which could be towed by tugs like a large bobbin paying off the pipe as it went.

Within a few months, a special factory at Tilbury, in the Thames Estuary, was equipped for welding 20-ft. lengths of the Hamel pipe into 4000-ft. lengths at a rate of 10 miles daily, with facilities for storing the lengths to a total of 350 miles a day. Shortly afterwards a duplicate factory was established in event the first should be bombed.

The floating drums, called H.M.S. Conun-drums (or "Conuns" for short), were moored in deep water at the end of the pipe-racks, so that the 4000-ft. lengths might be welded into a continuous length of 30 miles or more, and wound onto the Conuns while they rotated. A Conun is 90 ft. long, more than 50 ft. in diameter overall, and when fully

(Continued on Page 174)

...again three more

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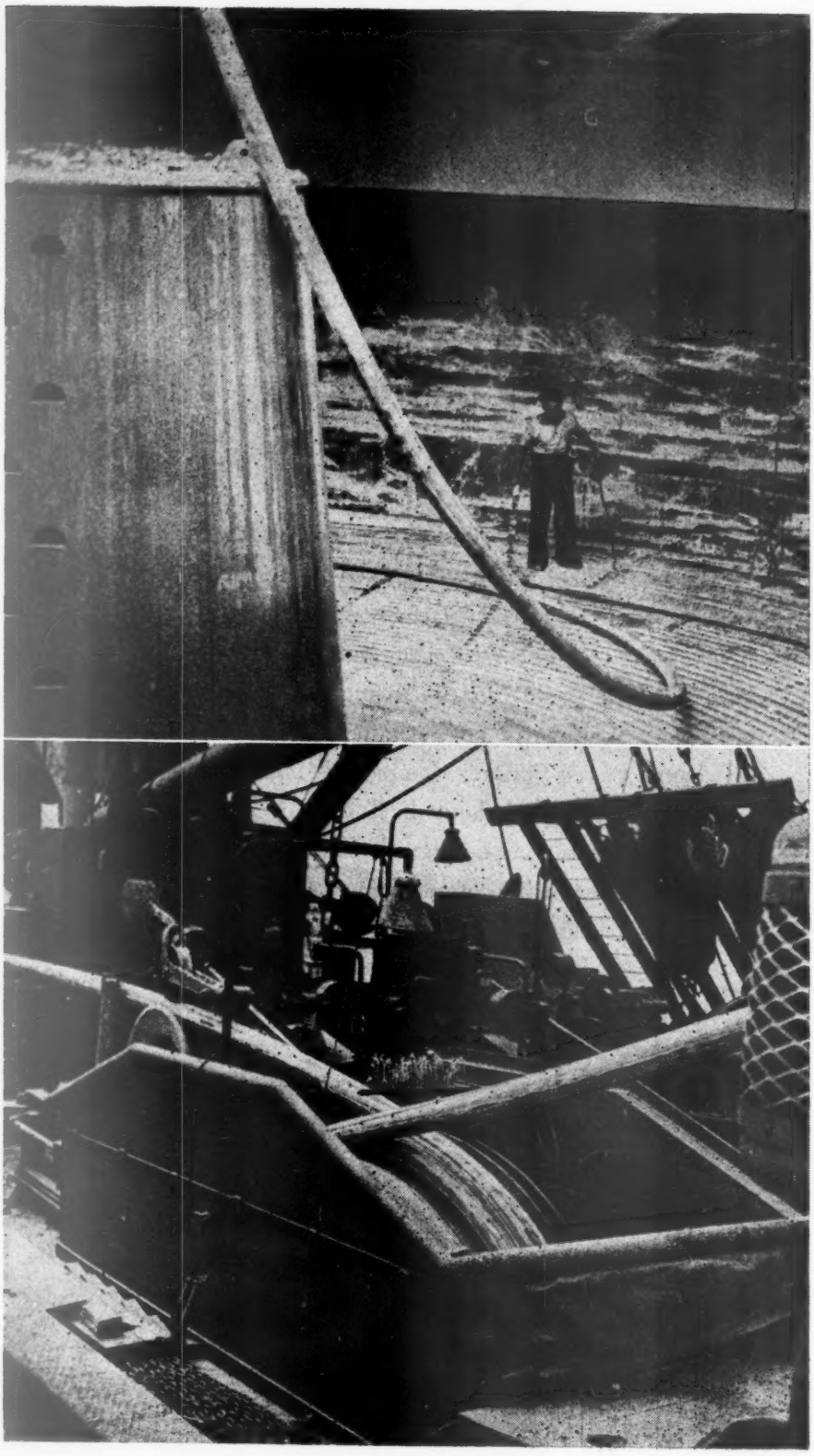
Dresser Industries is now a team of thirteen companies pooling their resources for better products, better service to their customers.

Dresser Industries, Inc.
Terminal Tower, Cleveland 13, Ohio



Top—The 3-in. Hais cable carried in the hold of the Liberty ship "Latimer" in one continuous length for the cross-channel pipe line. The pipe is built for working pressures of more than 1200 lb. per sq. in. *Below* is the cable passing around the cable drum during the laying operation. The flexibility of continuous pipe is evident.

(Continued from Page 170)

wound weighs 1600 tons—the weight of a destroyer. It can carry 70 miles of pipe line. The drum around which the pipe is wound is 40 ft. in diameter and 60 ft. long.

After the successful trials of the HAIS cable in April, 1943, Geoffrey Lloyd arranged that the manufacture of HAIS cable and Hamel pipe, and the coordination of the whole plan, together with provision for pumping stations on the English shore, should be the responsibility of Britain's Petroleum Warfare Department. The work then developed in conjunction with the Admiralty Department of Miscellaneous Weapons Development, whereas the Royal Navy accepted the responsibility of laying the pipes at sea. Thus Force Pluto was formed under Captain J. F. Hutchings of the Royal Navy, composed of ships of all sizes from 10,000 tonners down to barges and motorboats manned by British Merchant Navy seamen. The Force was placed under the command of Admiral Sir Bertram Ramsey, allied naval commander.

Force Pluto's main base was Southampton, England, with a secondary base at Tilbury. The Force numbered 100 British Merchant Navy officers and 1000 men. In addition to H.M.S. Holdfast, three merchantmen were fitted with the cable-laying machinery. Two could carry 100 miles and one 30 miles of HAIS cable. Thames barges were converted for handling the cable at the shore ends, where large ships could not operate. Six Conuns handled the Hamel pipe. New pipe lines were run from the British system to take the gasoline to the coast, and special high pressure pumping stations were cleverly camouflaged. One of these was in a row of blitzed houses at Sandown, on the Isle of Wight; another was in an old fort built in the 1860's against possible invasion by Napoleon III, and others were in a modern amusement park and in seaside villas at Dungeness.

Operation Pluto began as soon as the mines had been swept to the approaches to the tip of Cherbourg Peninsula. The lines running from the Isle of Wight to Cherbourg took 10 hours to lay and transported gasoline to the United States armies. The lines established as soon as Boulogne was captured, from Dungeness to Boulogne, took five hours to lay and transported gasoline to the British 21st Army Group. Men of the Royal Army Service Corps pumped oil to cleverly concealed pumping stations on the French coast, frequently in rough weather, having to wade up to their necks to bring in the end of the line from the ships. An R.A.S.C. petroleum unit also maintains direct contact with the French terminals by cross-Channel wireless-telephone, thereby instantly detecting and reporting variations in the quantities delivered.

Paying tribute to this British engineering feat, Prime Minister Churchill said: "A large part of the Allied Expeditionary Force has been supplied with petrol by this unique method, which provides for petroleum the same kind of facilities upon a hostile shore that the Mulberry (prefabricated) harbors provided for general military stores. Operation Pluto is a wholly British achievement and a feat of amphibious engineering skill of which we may well be proud."

General Dwight D. Eisenhower expressed his "warm appreciation of the work the Pluto pipe lines have done in supplying United States as well as British forces in their drive into Germany."

EDITOR'S NOTE: This article and photographs were supplied by British Information Services, an agency of the British Government. ★★★

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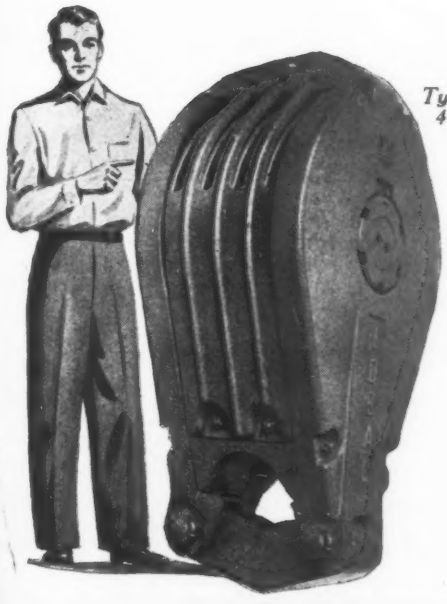
GENERAL SPECIFICATIONS

Rated Capacity, tons	300
Sheaves, diameter	48"
*Sheaves, API Groove, Size Line	1¼"
Upper Pin, diameter	3½"
Center Pin, diameter	10¼"
Lower Pin, diameter	7½"
Clevis Pins, diameter	4½"
Clevis, Depth and Width	11" x 6"
Side Plates, Distance Across and Length	51" x 88½"
Width Overall	34"
Length Overall, 548-T & 548-TC	9' 8"
Length Overall, 548-TCH	8' 0"
Net Weight, 548-T, pounds	11,251
Net Weight, 548-TC, pounds	11,928
Net Weight, 548-TCH, pounds	10,928

*These sheaves can be grooved for 1⅛" line when desired.

IDEAL *88-inch Traveling Block*



Type D-12 4 Sheave

BLOCK SIZE	D-6	D-12	D-20	D-20
Ratings	60 Tons	120 Tons	200 Tons	*200 Tons
Number of Sheaves	3	4	4	5
Wire Rope Dia. Std., inches	1	1⅛	1⅛	1⅛
Sheave Diameter, inches	30	34	38	38
Center Pin Diameter, inches	5⅛	7½	9⅛	9⅛
Lower Clevis Section, width and depth	3 x 6	4½ x 8	5½ x 10	5½ x 10½
Lower Clevis Pin Diameter, inches	1¾	2½	3¼	3¼
Length (Overall)	4'—8"	5'—7⅛"	6'—4½"	6'—5"
Width (Overall), inches	32¾	36¾	40¾	41
Face (Thickness), inches	16⅞	24⅛	30⅛	35⅞
Net Weight, pounds	2450	4030	7150	7850
Weight, Packed for Export, lbs.	2650	4180	....	....

* The 5 sheave D-20 traveling block is rated at 200 tons when used with the 6 sheave D-20 crown block. However, the 5 sheave D-20 traveling block rating can be increased to 250 tons when it is used with a larger capacity crown block.

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GRAPHIC ENGINEERING

By **ERNESTINE ADAMS,** *Associate Editor*

Method of processing drawings for reproduction saves paper, improves legibility, permits more copies.

EXCLUSIVE To make clear, readable reproductions of plans, designs, flow sheets, maps, and diagrams is an engineering process of the graphic arts. Most companies that need copies of drawings stick to blueprints because it is in the tradition rather than decide to use any of a variety of other methods. The reproduction method for each drawing should be selected on the basis of what would be best considering the ultimate use of the copies.

Blueprinting is a direct copy on blue paper of an original drawing, black lines being reproduced in white. Best results are from evenly woven, transparent paper on which the diagram and lettering are in black ink. Size of the blueprint must always be the same as the size of the drawing. Copies are limited, for each one must be made directly from the original and the transparent paper gets rough and opaque in time. The white lines on the blue are not high on the scale of legibility for color combinations, and the blue background grows paler as the drawing becomes worn.

In many instances, however, the quick, easy blueprint is the most satisfactory method. There should be sufficient cause on one or more of three points to venture into other forms of reproducing a drawings, many of which are unfamiliar to draftsmen.

First, quantity must guide the decision. The larger the number of copies desired, the more reason for getting away from blueprints.

Second, size must be considered. If there is any advantage in reducing or enlarging the size of a drawing, then some method such as photostating must be used as an intermediate step or as the final method. Drawings can be radically reduced if properly prepared for reproduction and large quantities of paper can be thus saved. It is obvious that the smaller the imprint the sharper must be the lines to be imprinted.

Third, legibility importance must be determined. Need for high legibility depends somewhat upon the use of the reproduction. If copies are being sent out for study they will have far different treatment from those used by workmen on a construction job. A white background with black lines is the easiest read but it also gets soiled quickest. White lines on blue background are not very permanent either.

The flow sheet in Fig. 1 is an etching of a blueprint that is 8½ by 11 in. Fig. 2 is the same blue print after it went through the graphic engineering process. It is now ready to be reproduced by photostating, multigraphing, multilithing, printing, or lithographing. The number of copies needed would determine the method as far as cost is concerned. In general the cost per copy would decrease as the number of copies increased in the order of the methods named. For instance, photostating is the quickest and cheapest method for a few copies. If the number runs into thousands, the best method would probably be printing.

In preparing Fig. 1 for reproduction the first step was to have a positive photostat made of the blueprint. In this case the photostat was made more than twice the size of the final version in Fig. 2 because it is easier to work with larger size print and engravings are better when reduced.

Close scale may not be easy to maintain with a photostat but usually the small difference in proportion caused by paper shrinking or stretching is negligible. A good operator can avoid the distortion by taking a negative one way and turning the negative on its side to take the positive. A photostat made with film instead of directly on paper is more accurate although more expensive.

For the designations on the flow sheet, the names are typed off and sent to a typesetter. He sets them in the kind of type and in whatever size ordered and takes several good proofs of the type on gummed paper or on white enamel paper. Almost any sans serif type face is all right. The size depends upon whether the working copy is to be enlarged or reduced or both. White enamel paper and rubber cement are preferable to gummed paper unless the paste-ins are numerous and small.

The words and figures are then cut out and pasted on the photostat, covering the hand lettering as much as possible. Chinese White is used to go over any marks still visible. The clear-cut

FIG. 1. This etching was made from a photostat, which was in turn taken from a blueprint. An engraving, such as this, cannot be made directly from a blueprint, but a black and white photostat can be made from it.

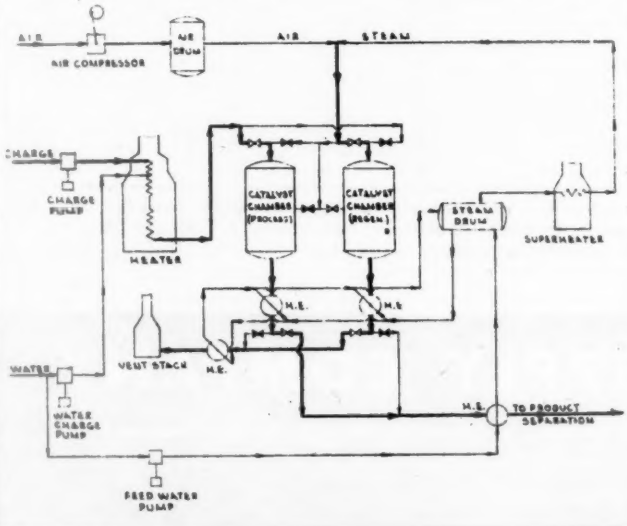
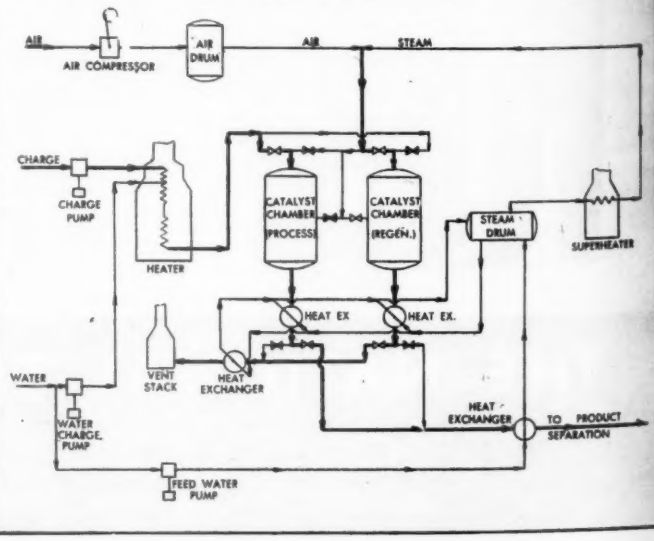


FIG. 2. This is the same as Fig. 1 after lines of the diagram were inked and printed designations were pasted over the hand lettering. Chinese White was used to cover some lettering. Reproduction is uniform.



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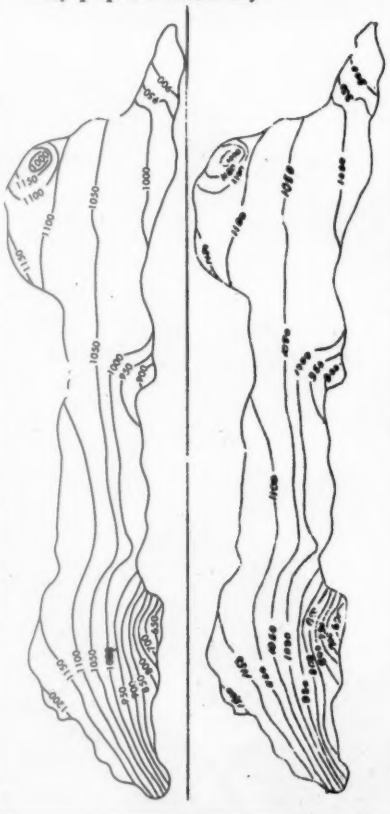
type, which now designates each item, allows the best reproduction obtainable. If the lines of the drawing are not black enough they can be gone over with black ink to insure good reproduction.

Fig. 2 has now gone through the graphic engineering process and is in much the same shape as an advertisement being finished up in the art or production department in an advertising agency. The steps are simpler but results are just as gratifying. The flow sheet now can be enlarged or reduced in a wide range, say from half the size to twice the size. It can be photostated, multigraphed, printed, etc., with assurance of clear reproduction.

Fig. 3, a bottom-hole pressure map, is made from a mimeograph copy. In this instance the lines were traced and the printed figures gummed on the tracing. It could have been done in the same manner as Fig. 2. Fig. 4 shows the map after it had been prepared for reproduction. Figures are especially difficult to letter clearly by hand but the printed labels show up well. Time required for the preparation on the map was about 10 minutes, counting the tracing, typing the figures for the printer, and pasting them on. The actual process is easy to learn and practice, of course, makes for speed.

FIG. 3. ***Right*****—This etching was made directly from a mimeograph copy of the map. Mimeographing presents great difficulties in reproducing drawings unless they are very simple and speed is a major item.**

FIG. 4. ***Left*****—A tracing of Fig. 3 with figures, proofed on gummed paper, pasted on. Gummed paper is not so reliable as paper cement; a piece may pop off when dry.**



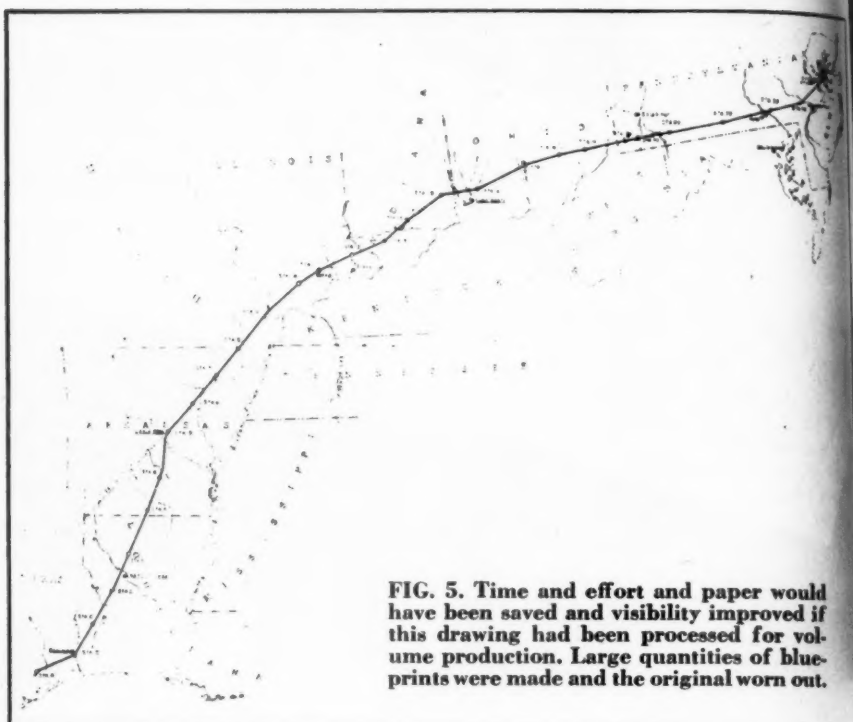


FIG. 5. Time and effort and paper would have been saved and visibility improved if this drawing had been processed for volume production. Large quantities of blueprints were made and the original worn out.

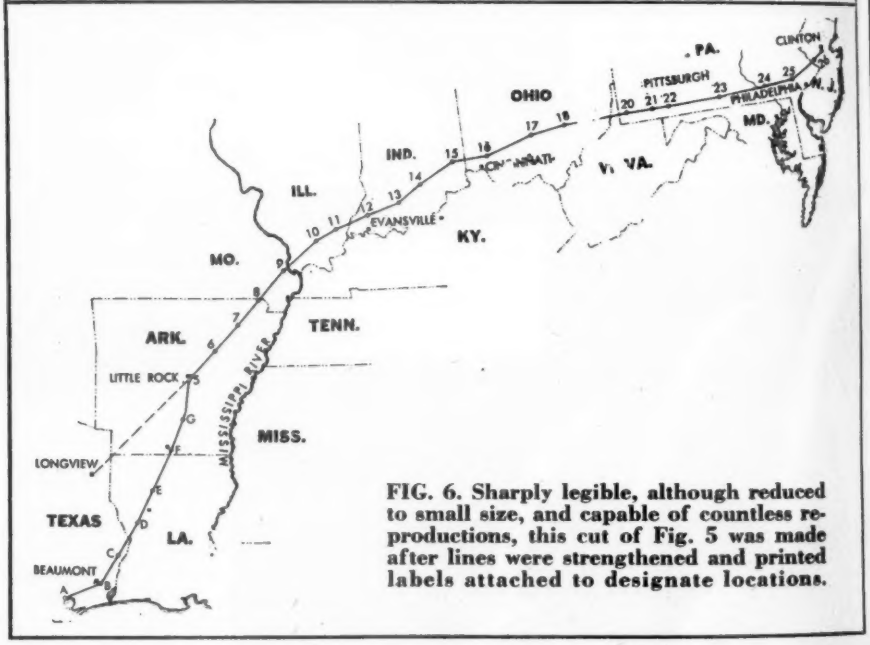


FIG. 6. Sharply legible, although reduced to small size, and capable of countless reproductions, this cut of Fig. 5 was made after lines were strengthened and printed labels attached to designate locations.

The third of this before-and-after series is a map of the Little Big Inch pipe line. Fig. 5 is a photostat, evidently taken from a blueprint that had passed its clear days. Fig. 6 is a cut made after the map had been processed for reproduction. It shows the advantages of type when differentiation is needed for various classes of names. Here the names of states are in 18 point size extra bold Futura and the cities and station numbers are 14 point medium Futura type face. Despite some variation in hand lettering and wricoprint there is a sameness that is hard to avoid. Underlining, which is sometimes used for greater emphasis or clarity of meaning in lettering, cuts down on legibility, especially if it touches the letters. Not only is type much more easily reproduced, it also offers the widest variety for distinctive work.

Cost of preparation of a drawing for reproduction depends on size and number of paste-ins. Photostats are priced by size; the proofs of designations are priced by the length of time it takes to set the type. These shown here would run up to $1.50 at the most, not counting the time of the graphic engineer. Time required to process any of the three is about 15 minutes, more or less, including the designation typing, the pasting, the overdrawing, and the clean-up with Chinese White.

These prepared copies cannot be used for blueprinting unless a reproduction is first made on transparent paper. They can be used directly for any other kind of imprinting, however, and they offer the most legible and most versatile form for reproduction for any use. ★★★

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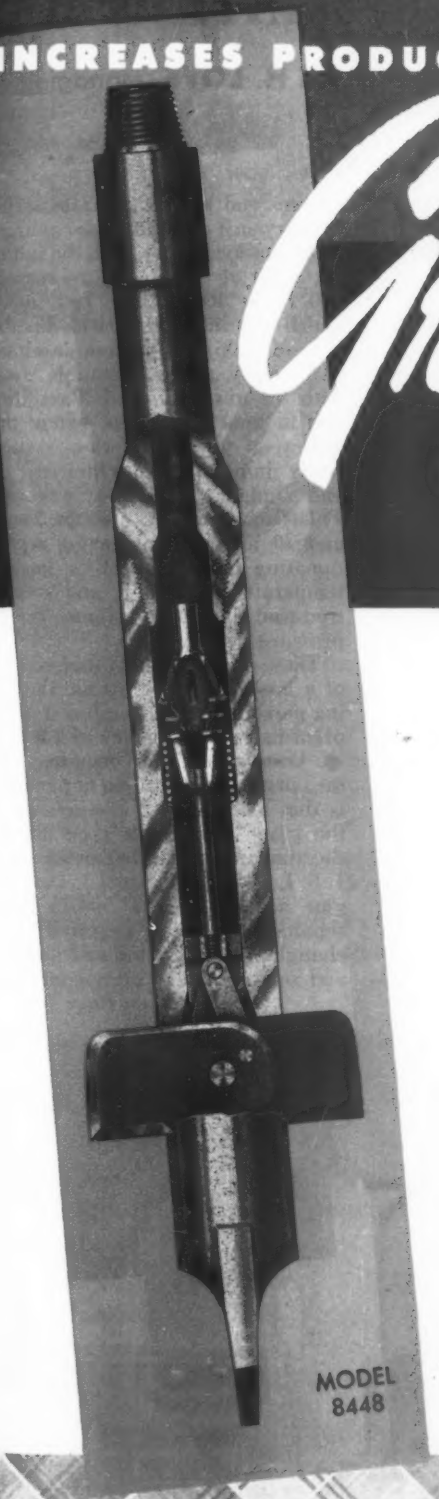
INCREASES PRODUCTION—SAVES CASING—ASSURES BETTER CEMENT JOBS

Grant 2-BLADE HYDRAULIC EXPANSION WALL SCRAPER



The GRANT Wall Scraper is a many-purpose tool, vitally important for every drilling program. It is used to enlarge the hole in the area of the exposed producing sand, and to enlarge the hole in SOFT formations to permit running larger casing. To secure a better cement job, it is used to enlarge the hole above the setting point of the shoe, thus assuring a thick body of cement around the casing which will not be disturbed in following drilling operations. When placing a cement plug, the Wall Scraper enlarges the hole at the point where the plug is to be set, thus exposing the formation which creates a better bond for the cement. Also Gravel Packing, Water Shut-Off Tests and Cutting Out operations on drillable pipe are performed more effectively with the GRANT Wall Scraper.

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☐ Safety Automatic Pressure Releases (Mud Pumps)

GRAPELAND CYCLING PLANT OPERATING DATA

By **FRANK H. LOVE,** *Managing Editor*

EXCLUSIVE Cycling is one of the comparatively newer branches of the petroleum industry, the first plant having been placed in operation in 1938. Since the construction of this first unit numerous other installations have been made, wherever gas-condensate production was found, because only by this particular type of processing can the greatest recovery of hydrocarbons and natural gas be effected. Some of the plants are of the refrigeration type; the greatest number, however, utilize the absorption method. Capacities vary widely, from approximately 7,500,000 cu. ft. to 200,000,000 cu. ft. of gas-condensate a day.

At the outset, considerable experimental work was necessary to determine the best processing methods to use and the best type of equipment to install. These problems have now been largely solved and certain standards established. In view of what has been learned, it is interesting and beneficial to know the history and operating record of some of the early plants—those that pioneered cycling. One such plant is that of the Geier-Jackson Recycling Company at Grapeland, Houston County, Texas. This plant was put on absorption October 1, 1941, although the compressors had been running since July 1 of that year recovering condensate. With a maximum capacity of 52,000,000 cu. ft. a day, the total volume of gas processed from July 1, 1941, to April 1, 1945, was 42,623,989,000 cu. ft. Total production of all products was 57,862,435 gal., which included gasoline, butane, propane, isopentane, naphtha, kerosine, and gas oil. Plant efficiency during this period was 136 per cent.

The Geier-Jackson plant has had what might be termed an evolutionary history. When it first began operating only three products were manufactured: (1) Motor fuel, (2) kerosine, and (3) gas oil. Equipment was added from time to time with the result that the seven products enumerated in the preceding paragraph now constitute the plant's output.

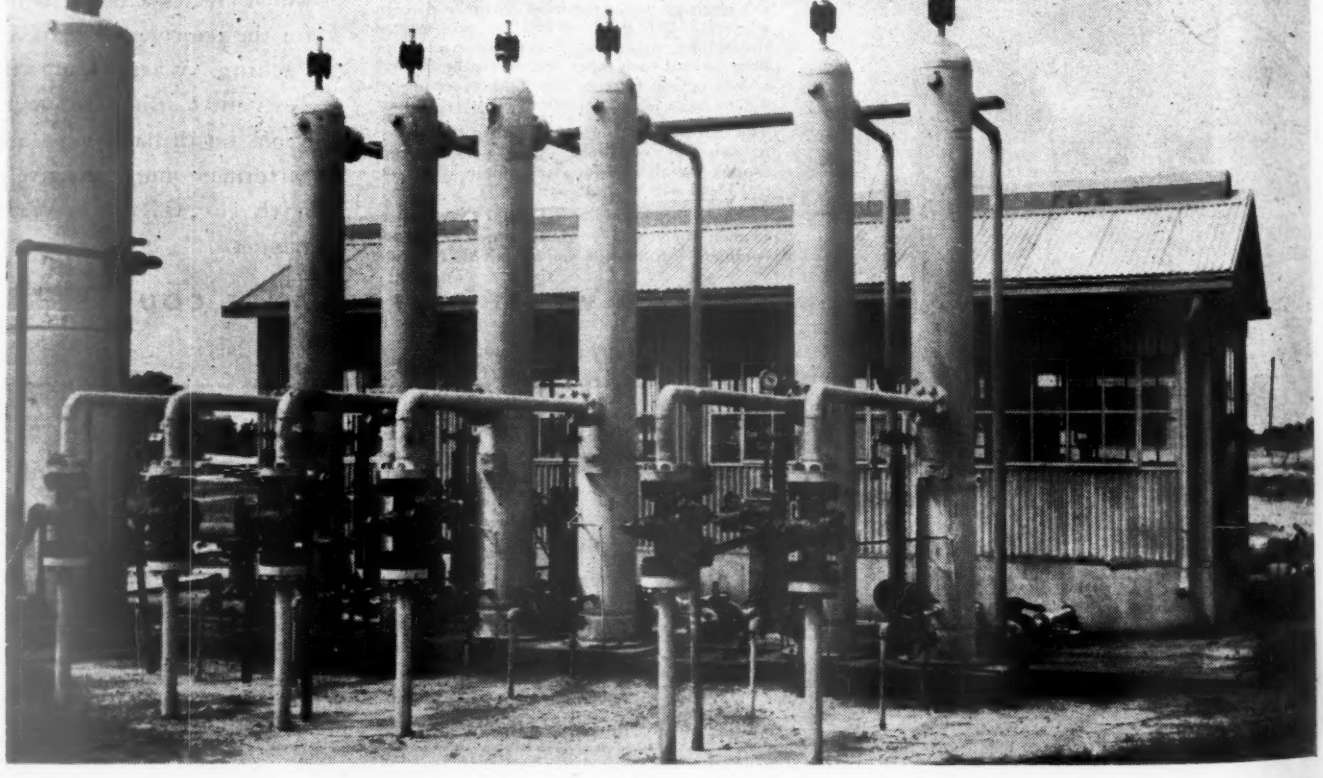
The first addition to the plant was made in February, 1942, when a column was installed for the recovery of butane, the butane being taken off as a mixed product including both normal and isobutane. In February, 1943, a secondary still, deisopentanizer, deethanizer, and a naphtha column went on stream, adding naphtha, pentane, and propane to the list of products manufactured. The purpose of setting the secondary still was to cut a lower end point on products from the primary still overhead, also giving better fractionation. As a result, the initial boiling point of gas oil was increased from 260°F. to 360°F. The last unit to be added was in March, 1943, for the purpose of making 87-octane gasoline.

As early as 1942 trouble developed with the absorption oil. Paraffin deposited in lines to such an extent that efficiency of the absorption system was badly impaired. To eliminate paraffin and sludge a reclaimer was installed. This consisted of a column 14 ft. high and 40 in. in diam. having seven fractionating trays. The oil is heated to a temperature of 590°F. and steam is introduced into the column for partial pressure fractionation.

These additions and other adjustments of a lesser nature, plus an alert operating personnel, have combined to give the plant its rated efficiency of 136 per cent.

● **Compressor performance.** One of the outstanding equipment performances is that of the No. 2 compressor, one of the plant's two angle type units. From the time the plant began operating on July 1, 1941, until April 1, 1945, this engine has operated 31,504.75 hours. No repairs have been required, only the changing of magnetos and spark plugs, and operation has been continuous ex-

(*Continued on Page 184*)



Condensate is separated from the gas in these primary separators.

other facilities—most of them built during peace—have proved invaluable in war. Time and again equipment of our world-wide organization has been used by the Armed Forces to perform vital tasks."

Employees Maintained a Fine Record—"There were no production stoppages due to strikes—a record which has been maintained since long before Pearl Harbor . . . About half the employees had records of 10 years or more of service and over one-fourth had been employed more than 20 years . . . over 1,000 employees have already returned to the Company from military service. In addition 632 veterans not formerly with us have been employed."

The Future—"Supplying the petroleum needs of wartime will continue to take priority over all other Company considerations so long as the conflict lasts. Nevertheless . . . thought is being given to post-war problems such as the return of our men and women now in the Armed Services, oil reserves, reconversion, post-war products . . . The Company will be prepared for the opportunities ahead with an organization which, strengthened by the return of employees in service, will be better equipped than ever to serve the public both at home and abroad."

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BUTYL RUBBER
CABLE OILS
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COMPRESSOR OILS
CONTAINER LINING
CUMENE
CUTTING GASES
CUTTING OILS
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DI-ISOBUTYLENE
EMULSIFIED CUTTING OILS
ENGINE OIL
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ETHYLENE
EXTREME PRESSURE LUBRICANTS
FLIT
FOG OIL
GEAR OILS
GRAPHITE GREASES
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HYDRAULIC BRAKE FLUID
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HYDROGEN
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ISOPROPYL ACETATE
ISOPROPYL ALCOHOL
JET PROPULSION FUEL
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SOLVENTS
SPARK PLUG LUBRICANT
STEERING ENGINES
SUPERCHARGER OIL
TEMPERING OILS
TENTAGE TREATING COMPOUND
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TORPEDO TAIL PACKING COMPOUND
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UNDERWATER GEAR GREASES
WATERPROOF GREASES
WAXES
WHITE OILS

STANDARD OIL COMPANY (NEW JERSEY)

AND AFFILIATED COMPANIES

(Continued from Page 180)

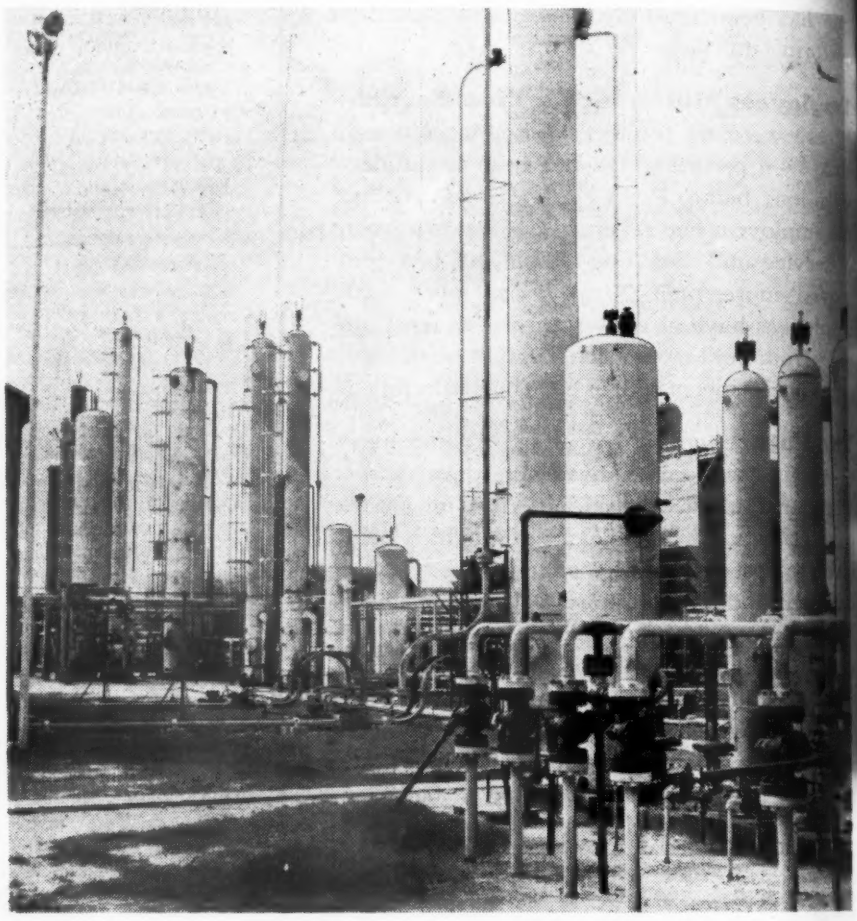
cept when making these changes. Down time for this purpose has totaled only 31.25 hours. Furthermore, the oil has never been changed in the engine, although periodic analyses have been made to determine its condition. Oil has been added of course as needed, the total amount of oil used being 8,790.25 gal. The horsepower hours per gallon of oil is 1792.

The No. 1 compressor also has an excellent record, although not quite comparing with that of the No. 2 unit. Two new pistons and two new cylinders have been installed in the No. 1 compressor and the oil has been changed once.

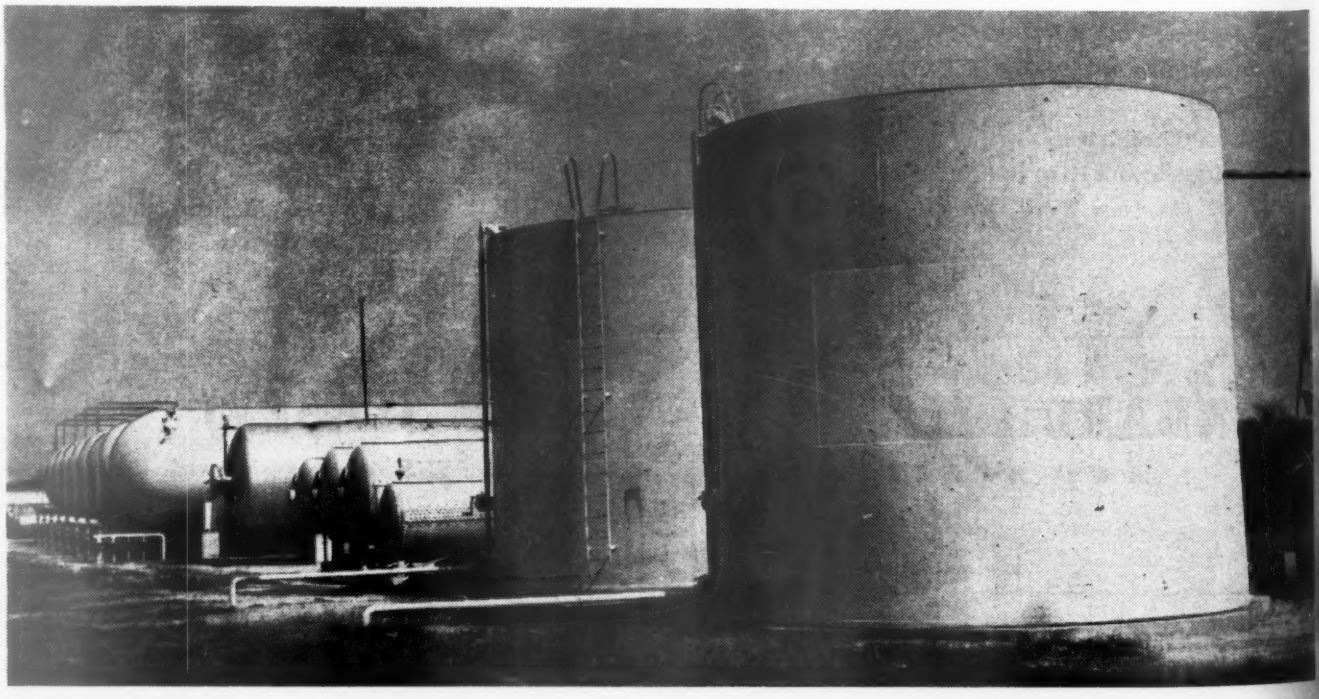
● **Plant operation.** Although the maximum capacity of the plant is 52,000,000 cu. ft. a day, and at times that volume is processed, the plant's customary throughput is from 35,000,000 to 40,000,000 cu. ft. Six wells are connected to the plant and each delivers its gas through an individual line. Metering is at the plant, each well being metered separately. Production is from the Woodbine formation at depths from 5900 to 6000 ft. After being metered the gas passes through six primary separators where condensate is dropped out and the overhead gas is metered before going to the high pressure absorber. Condensate dropped out in the primary separators does not go to the high pressure absorber, but bypasses to the high pressure reabsorber where it is flashed at a pressure of 400 lb. Rich oil from the high pressure absorber also flows to the high pressure reabsorber and is flashed at the same pressure. The combined streams are again flashed by reducing the pressure from 400 lb. to 85 lb. in a low pressure reabsorber and is then heated by means of heat exchangers and discharged to the primary still. The reabsorber also serves to control the pressure of the primary still by controlling the feed tank pressure. Dry gas from the high pressure absorber passes to two 500-hp. angle-type compressor units. The compressors take the gas at a pressure of 1500 lb. and discharge it to an injection well at 2400 lb.

The primary still flashes off overhead the lighter fractions, which include 6-lb 80-octane all-purpose gasoline having an end point of 325°F., butane, isopentane, and propane.

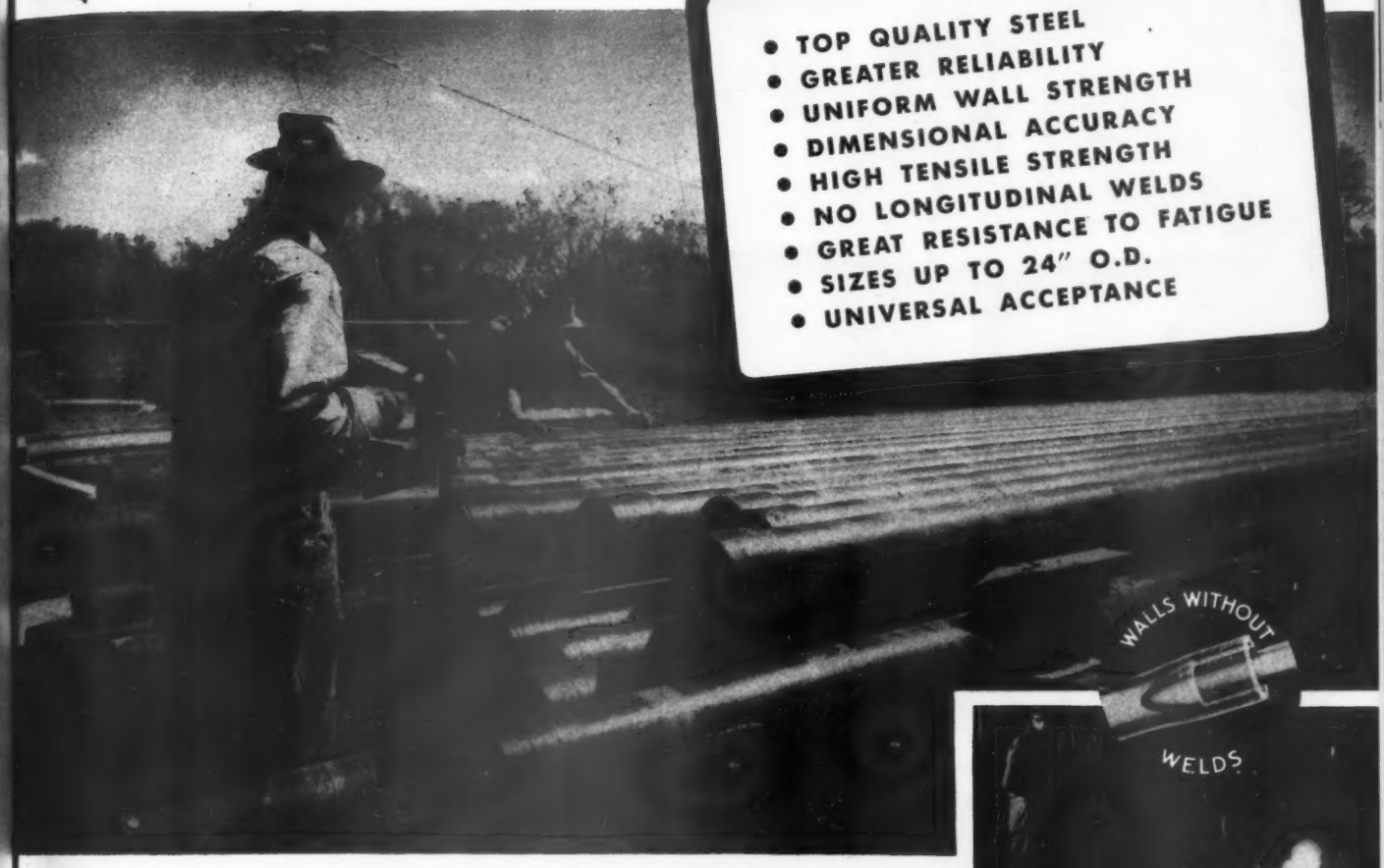
Bottom products from the primary still are discharged to a secondary still by means of a drop in pressure and a liquid-level control. Gasoline and naphtha having an end point of 400°F. are taken off overhead, kerosine comes off as



***Right*—Absorption, distillation and fractionating columns. *Below*—Storage tanks for finished products.**



"I'll take NATIONAL SEAMLESS in my share of those 27,000 new wells"



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WHEN it comes to all around good performance, many a driller has said, "I'll take NATIONAL Seamless every time!" And now that the industry is about to burst its buttons trying to reach a goal of 27,000 new wells, it will pay doubly well to use the drill pipe, casing and tubing that have piled up such amazing records in the past. That means NATIONAL Seamless.

Time and time again old customers have told us that they are glad they used Seamless. You, too, will be glad you used Seamless in your share of the new drilling program. Seamless means uniform wall strength with no longitudinal welds, means fewer twist-offs, means fewer fishing jobs, means great collapse strength, means greater security of every kind.

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This is the piercing process used in making NATIONAL Seamless Pipe and Tubing. Only the finest quality steel can be successfully pierced. The piercing and subsequent operations in making a seamless tube redouble your assurance that every length of NATIONAL Seamless will display the same uniform wall strength, dimensional accuracy, and uniform performance on the job.

National Seamless Oil Country Goods

Seamless A. P. I. Drill Pipe (Internal Upset and External Upset)

Seamless A. P. I. Casing (Non-Upset and Internal Upset)

Seamless Cement Lined Casing and Tubing

Seamless A. P. I. Tubing (Non-Upset and External Upset)

NATIONAL SEAMLESS *drill pipe... casing... tubing*

NATIONAL TUBE COMPANY — USS STEEL — UNITED STATES STEEL

NATIONAL TUBE COMPANY

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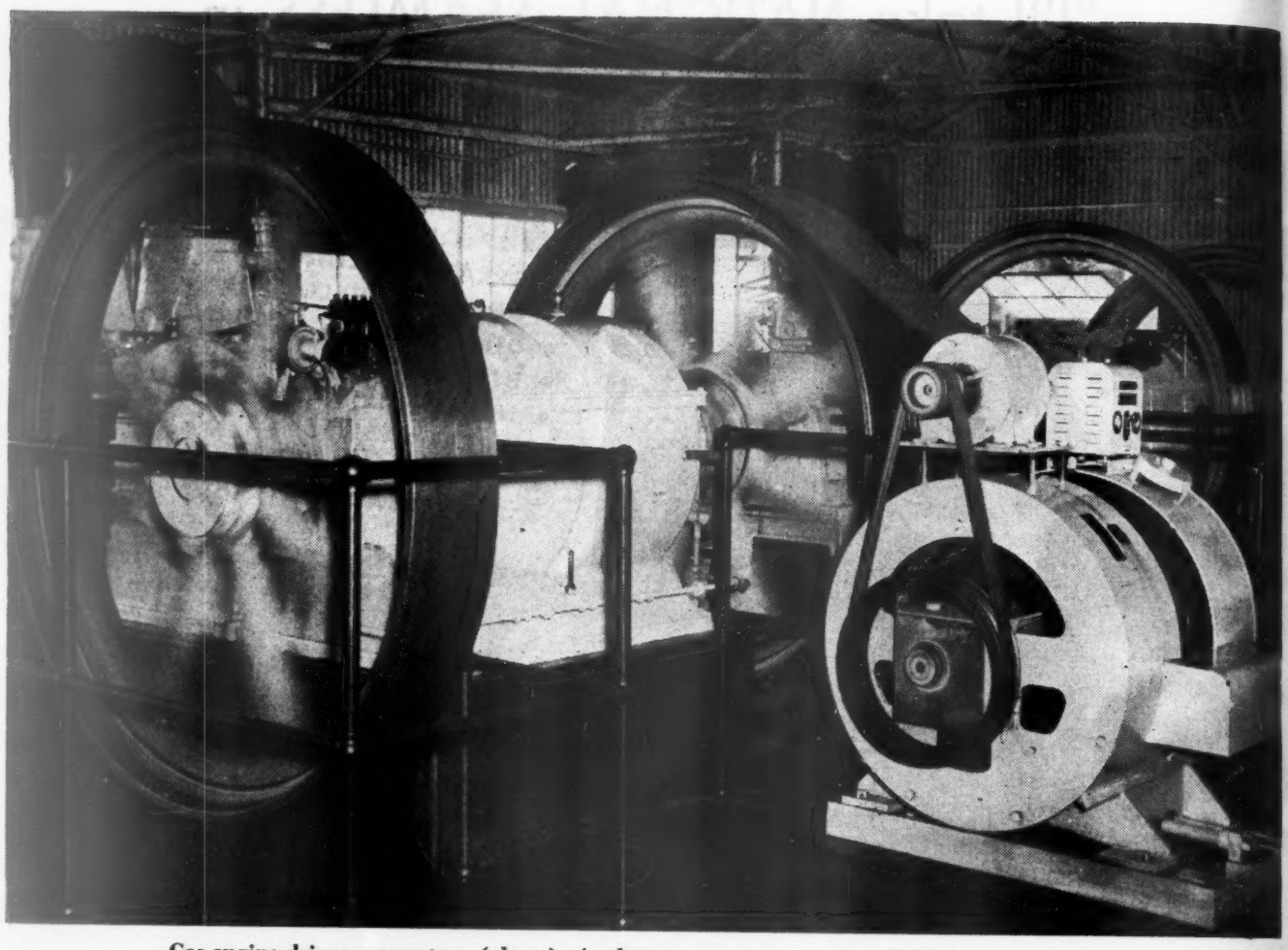
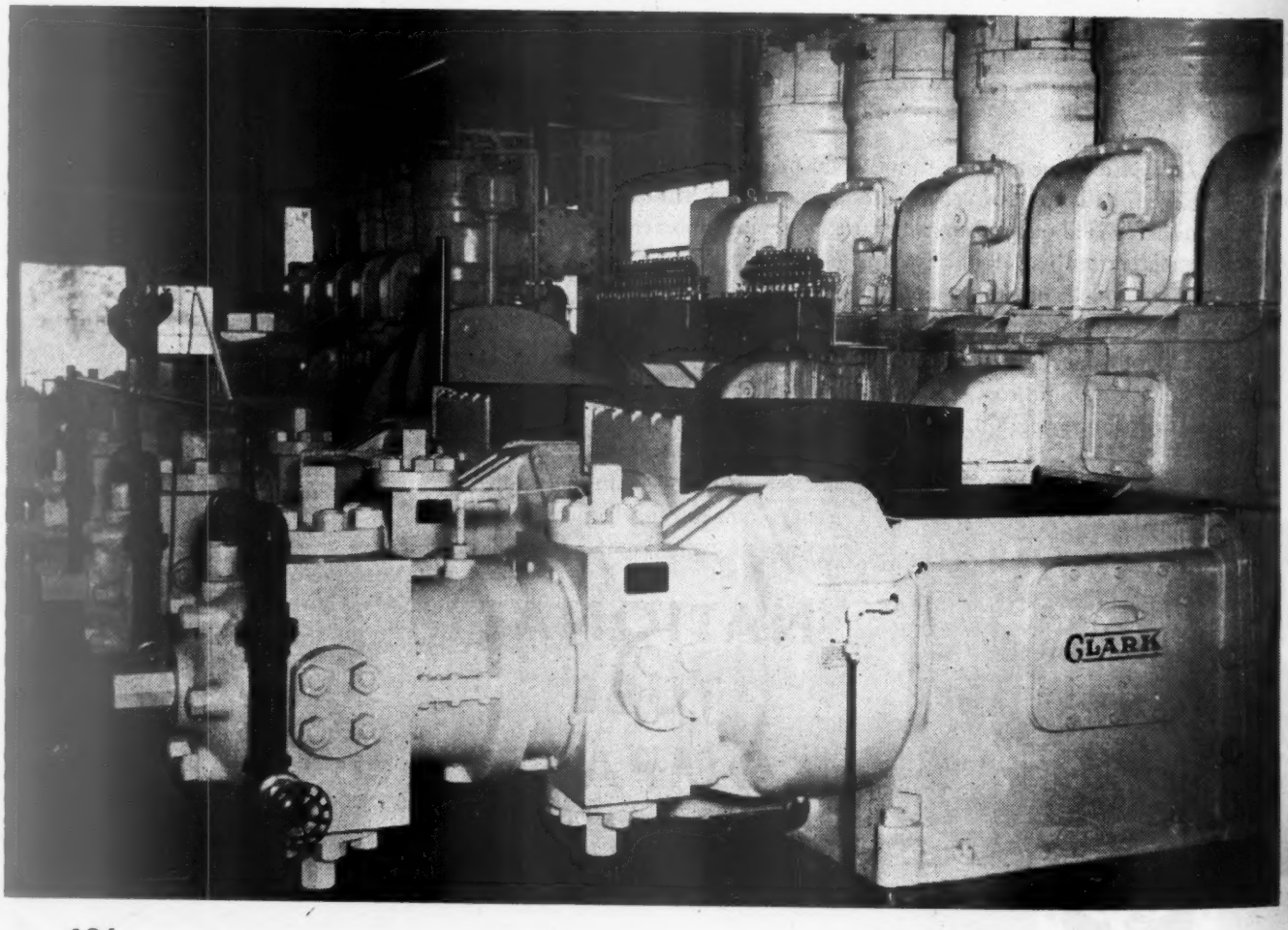
UNITED STATES STEEL



Gas-engine-driven generators (above). Angle-type compressor units of 500 hp. each (below).



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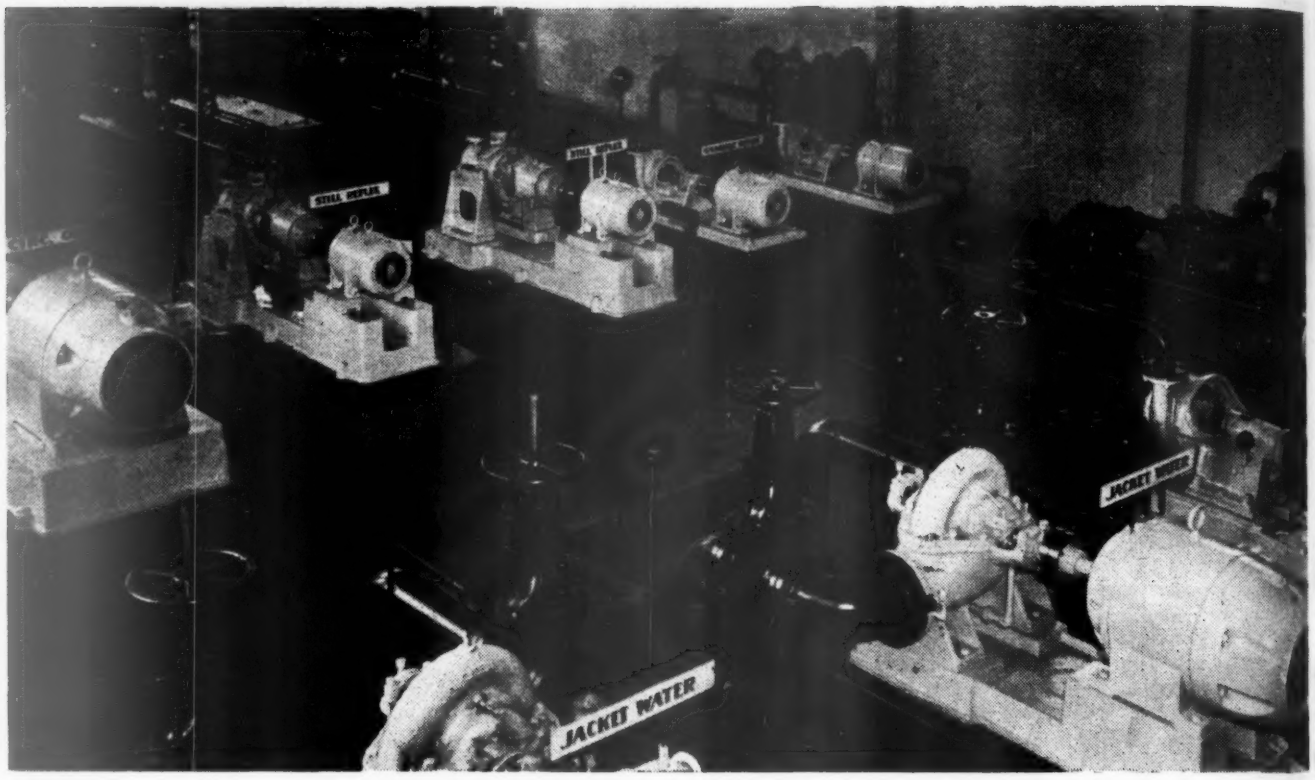

Interior view of a part of the pump house.

a side stream, and gas oil, which is used as absorption oil, comes off as the bottom product.

The light fractions from the primary still are condensed and discharged to an accumulator, which has two purposes: (1) Serves as a reflux accumulator, and (2) provides feed stock to the depropanizer. Materials are fed to the depropanizer by a flow controller and steam pump. Propane and ethane are the overhead products and bottoms are moved to the debutanizer by dropping the pressure from 270 lb. to 80 lb. Butane leaves the column overhead and bottoms, by dropping the pressure from 80 lb. to 25 lb., are discharged to the deisopentanizer. The top product from this column is isopentane and the bottoms 6-lb. 80-octane base stock.

From the reflux accumulator, ethane and propane are fed by a liquid-level controller to the deethanizer, where ethane is taken overhead and propane comes off the bottom.

The gasoline and naphtha that pass off the secondary still are condensed and dropped into an accumulator for refluxing, with the surplus being fed into the naphtha column where gasoline goes off overhead and naphtha is taken from the bottom.

Gases from the high pressure and low pressure reabsorbers are used for plant fuel.

● **Absorption oil.** The high pressure absorption oil pump is a mud pump of the type used on drilling wells that was converted to its present use by changing pistons and cylinders on the fluid end. The power end is rated at 250 hp. at 200 r.p.m. The pistons are of 3⅛ in. diam. When the lean oil leaves the secondary still it passes through heat exchangers countercurrent to the rich oil, the temperature declining from 520°F. to 150° F. It is then pumped to the cooling tower where the temperature is further reduced —to as low as 50°F. in the winter and to as high as 90°F. in the summer. The cooled oil is fed into the high pressure oil pump, to be discharged through the high pressure absorber to the high pressure reabsorber oil pump. From the high pressure reabsorber the flow is to the low pressure absorber. The reabsorber oil pump is a 700-lb. piston pump that is run by gas dropped from 400 lb. to 75 lb. pressure.

● **Lean oil heater.** Lean absorption oil is used for heating instead of steam. The oil is circulated to the heater from a surge tank that is equalized with the bottoms of the still. The heater is of the blast furnace type, the tubes through which the oil flows being heated by a distant blast rather than being exposed to a direct flame. Circulation of the lean oil is by means of a centrifugal pump, at a rate of 700 gal. per min.

● **Electrical generation.** Electrical power is generated by two synchronized 165-hp. gas engines that drive two 125-kw. generators equipped with automatic voltage controllers. In addition to supplying lights for the plant, the electricity is utilized for the motor-driven centrifugal pumps (most of the pumps being of this type), to drive the motors operating the cooling tower fans, hot oil circulating pumps, primary still reflux pump, isopropane reflux pump, debutanizer reflux pump, rich and lean oil pumps, water circulating pumps, and deisopentanizer pump. Horsepower ratings of the various motors are as follows: Those operating the cooling tower fans, 35 hp.; circulating oil pumps, 50 hp.; rich and lean oil pumps, 25 hp.; water circulating, 40 hp.; still, 15 hp.; debutanizer, 7½ hp., and deisopentanizer, 7½ hp.

● **Cooling tower.** The cooling tower is of the induced-draft type and has a capacity of 5000 gal. per min. Four 10-ft. fans are operated by 35-hp. motors.

● **Steam.** Steam is generated by three 125-hp. oilfield type boilers having a working pressure of 350 lb. Although steam is not used for heating, it is utilized for agitation on the primary still and for operation of certain pumps. Among the latter are the three loading pumps, the depropanizer feed pump, the depropanizer reflux pump, the boiler feed pump, and the boiler makeup pump.

● **Storage.** Product storage at the plant consists of eight pressure tanks of 50,000 gal. each for butane, isopentane, and gasoline; a total of 60,000 gal. storage for propane, 3000 bbl. storage for kerosine and naphtha; a 750-bbl. slop tank, and a 1000-bbl. gas oil tank. Most of the storage, however, is at the loading rack and four lines have been laid to move it the distance of several miles. There are three 2-in. lines and one 3-in. line. Naphtha, kerosine, isopentane, and gas oil are pumped through the 3-in. line; butane, gasoline, and propane have individual 2-in. lines. Storage at the loading rack consists of six 5000 bbl. tanks, four 1000-bbl. tanks, and one 10,000-bbl. tank. The rack can load 15 cars at one time.

● **Water wells.** Two water wells have been drilled, one having a capacity of 85 gal. per min. and the other 250 gal. per min. ★★★

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(1) *2000-hp. motor*

A new 2000-hp. Tri-Clad motor, the largest to be added to this widely known line, has been announced by the motor division of the General Electric Company. A squirrel-cage induction-type motor, it is specially designed for use in large central power stations and large industrial applications.

The new motor is in the 6360-frame series, which is five steps larger in

diameter than the largest standardized frame (namely, 505). Operating at 1800 r.p.m., it is rated 2000 hp., 2300 volts, 3-phase, 60 cycles.

The motor incorporates all the basic protective features of the Tri-Clad line. These include protection against physical damage, electrical breakdown, and operating wear and tear. The end shields are of split cast-iron construction to facilitate maintenance and provide exceptional resistance to rust, corrosion, accidental blows, and rough usage.

(2) *Field-lite*

The manufacturing division of Buda Engine Sales and Service, Inc., Tulsa, Oklahoma, announces its new power and light plant unit called Field-lite. Made in two sizes, 5 kw. and 7½ kw. for direct current, this light plant is now available through any supply store.

Plans to make and sell such a unit began when the company learned the ultimate cost of a cheap light plant to the drilling contractors and the oil companies. After some three years spent in surveys, discussions with ultimate users, and field tests under varying conditions, the company believes Field-lite will find ready acceptance.

Both models are fully equipped with standard parts of reputable manufacturers, including oil filter, water temperature gage, oil pressure gage, voltmeter, ammeter, circuit breaker, rheostat, combination gas-gaso carburetor and fuel tank, natural gas intake connection, oil bath air cleaner, and a convenient outlet receptacle. Both models are protected by an adequate stock of replacement parts.

The engines are adequate for 25 per cent overload, and give constant duty at moderate speed. One of the important features is the ease of handling in moving from one location to another. Complete engineering data is contained in Bulletin 445.

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All items are numbered. A business reply card requiring no postage if mailed within the United States is provided. Check or encircle the number on the card that corresponds with the product or products in which you are interested and drop it in the mail. Literature and prices will be sent promptly.

BUY WAR BONDS

(3) *Gas analyzer*

The Hays Corporation, Michigan City, Indiana, manufacturer of gas analyzing equipment, announces the development of a special analyzer for testing the high purity of oxygen, carbon dioxide, and nitrogen in the range from 90 to 100 per cent.

It is of particular interest to the manufacturers of commercial oxygen and carbon dioxide but has many practical uses also in industrial processes. The new analyzer, known as the Hays Series "E," came into being as the result of the demand for testing the high purity of oxygen for use in flying, etc. It is quite

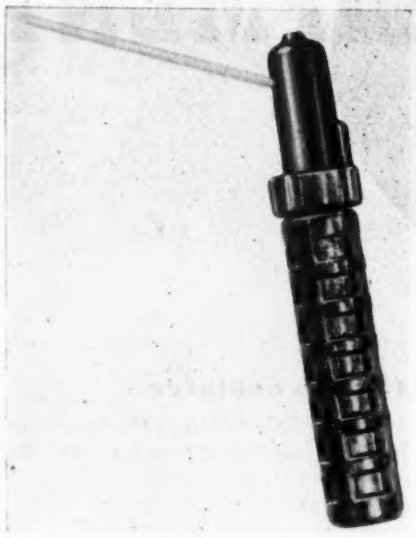
similar to the standard orsat but its technique in operation differs somewhat.

It is offered in two styles — a wall mounted model for permanent installation and a portable model supplied in a neat metal case with leather carrying handle. It may be had with a single unit or with two units. A junior model (Series EJ) is also obtainable with a burette capacity of 30 cc. The smaller model measures 6¼ in. by 9 ⅝ in. by 3¾ in. and weighs, fully charged, less than 6 lb.

All models feature a new 4-way valve designed by Hays engineers to conserve space and facilitate operation.

(4) *Electrode holder*

Designed to prevent slipping in the welder's mitt or glove when changing rods, an all-plastic, four-cornered collar has been incorporated in the 300-amp., Stubby model electrode holder manufactured by Martin Wells, Los Angeles, California.



It gives Stubby these additional features:

Makes rod-changing easy and fast, because it provides a positive, convenient grip on the insulator.

Holds small rods upright and away from contact with work because corners of "mitt-grip" collar keep holder from rolling.

Collar remains cooler than cap—making rod change comfortable.

Martin Wells improved Stubby model is available through principal local distributors, and nationally by Air Reduction. Home office is at 5886 Compton Avenue, Los Angeles 1, California.

(5) *Hunt bit*

Hunt Tool Company has recently placed on the market an improved design of welded-in blade drag bit that offers the user considerable time saving in blade replacements, according to the manufacturer. Made in 2-blade and 3-blade types of forged-steel blades, this new bit is especially designed for foreign operators, or U. S. operators whose drilling activities are far removed from the source of supply and at points where service men and shop facilities are not readily available.

This bit, referred to as "export model," is designed to simplify and remove possibility of error in blade replacement. In the 2-blade type positive correct location of blades has been accomplished by the drilling of a locating hole in the center or axis of the blades, and a locating pin in the blade slot of the bit head. The locating hole and pin are not required in the 3-blade type bit because this type blade cannot be moved laterally and can only be placed in the head in the proper position. The operator's crew can now replace blades in the field without the use of jigs, fixtures, or gages. No drilling edge grinding is necessary. The grinding, to insure blades that are sharp and to gage, as well as the setting of inserts and hard facing, are done by the manufacturer. All the user has to do is place the blade in the bit and weld.

The bit is supplied in sizes 5-in. to 25-in., with any connection desired.

Left: 2-way head. Note locating pin. Above: 2-way blade. Note locating hole. Right: Blade in head ready to weld.
2-way bit ready to run.
3-way Hunt welded-in blade bit, ready to run.

(6) *Fire extinguisher*

A new fast-acting portable fire extinguisher is announced by American-LaFrance-Foamite Corporation of Elmira, New York. It is the Alfite Speedex, made in 3 different sizes, Models 15, 10, and 4, and uses carbon dioxide as the fire extinguishing agent. The numbers indicate the pound capacity of the gas.

This new unit is engineered to extinguish more speedily small oil or electrical fires, with no loss of the important extinguishing gas on anything but the fire itself.

The Speedex operating valve lever is directly above the carrying handle. It can be instantly opened by the pressure of the hand grip and as quickly closed by releasing the hand pressure while operator is maneuvering his position.

For continuous operation the D-yoke ring is slipped over the operating lever while it is depressed.

All models are approved by Underwriters' and Factory Mutual Laboratories. Models 4 and 15 also carry the approval of the U. S. Coast Guard.

(7) *Pressure gage tester*

A new multi-purpose pressure gage tester developed by Mansfield and Green, Cleveland, Ohio, combines in a single unit a pressure gage tester that can be used with equal facility for bench testing and for portable testing in the field. On bench testing, the unit can be used with test gages or with a dead weight attachment.

A unique but simple doubly sealed check valve completely eliminates leakage and loss of pressure even with grit in the system, whether using oil or water and for pressures up to 10,000 lb. per sq. in.

Principal uses of the testing unit include testing and repairing of pressure gages and instruments, the setting of relief or other pressure actuated valves, and general hydrostatic testing.

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Dallas, Odessa, Tex.; Oklahoma City, Okla.; Centralia, Ill.; Casper, Cody, Wyo.; Bakersfield, Avenal, Ventura, Rio Vista, Santa Maria, Calif.

(8) *Drilling unit*

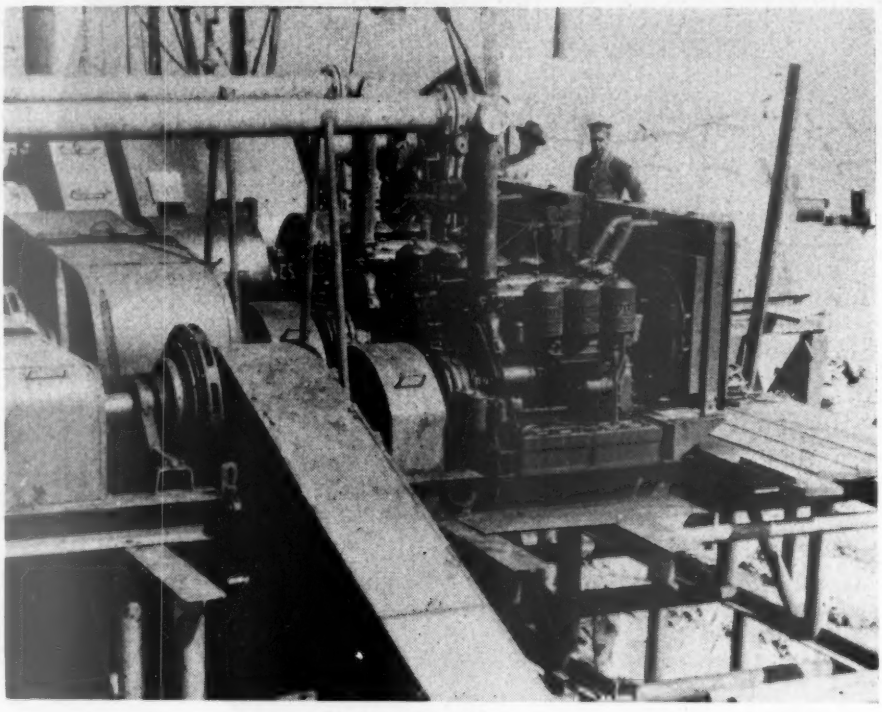
General Motors' 2-cycle, multiple diesel engine units, product of the Detroit Diesel Engine Division of General Motors, and operated by the Lee Drilling Company, Tulsa, Oklahoma, have just completed their first well in west Texas, drilling Stanolind Oil and Gas Company's Bryant Link No. 1 in Andrews County. They are now drilling a wildcat well northwest of Hobbs, New Mexico.

The engines used were two General Motors TWIN 6-71 units, rated for continuous service at 260 hp. each. The rig consists of an Emsco H-46 steam drawworks, converted by means of a Lucey reverse countershaft to internal-combustion engine drives. This drawworks embodies only one rotary table speed, which imposes severe operating conditions on the engines, as all rotary table speed variations can be made only by changing engine speeds. This limitation of the steam drawworks provided ample demonstration that these diesel engines will operate satisfactorily over an extremely wide range of speeds, the manufacturer points out. The two General Motors units were compounded by means of V-belt drives so that one engine could drive the drawworks and rotary table and one the mud pump, or, they could be compounded for hoisting. A 7¼-in. by 18-in. "Oilwell" mud pump and a 21-in. "Oilwell" rotary table completed the major items of equipment.

Each General Motors 6-71 TWIN unit consists of two 6-cylinder 4¼-in. by 5-in. 2-cycle engines, mounted together on a gear box, whose output shaft has a speed of 900 r.p.m. at 1600 r.p.m. engine speed. The engines are so designed that they can be assembled into a very compact, light-weight unit, with all working parts and accessories on the outside of the unit where they can be easily inspected or adjusted when necessary. The weight of each 6-71 TWIN unit, rated for continuous service at 260 hp. at 1600 r.p.m., is only 5300 lb., or less than 20 lb. per hp. continuous rating.

The well-known General Motors unit type injectors are used in these engines. These injectors, which also meter the fuel, fit in the cylinder head of the engine and can be removed quickly and replaced as a unit when necessary. No separate fuel injection pump is required, as these unit injectors both meter the fuel and inject the fuel into the combustion chamber at the proper time in the cycle.

The exhaust gases are scavenged by a change of air that is forced into the cylinder by means of a Roots type blower. This air thoroughly sweeps out all burnt gases through two exhaust valves situated in the cylinder head, and helps cool the internal parts of the engine, especially the exhaust valves. At the beginning of the compression stroke, therefore, each cylinder is filled with fresh clean air, which insures highly efficient combustion.



Two GM 6-71 units operating in West Texas field.

The driller controls the engine speed by means of a hand throttle wheel conveniently placed. The engines are protected by an overspeed governor.

Following are some of the statistics on the well:

Total depth, 7187 ft.; total hours, each engine, 1861; total fuel used, 18,973 gal.; total lube oil used, 161 gal.; number of fishing jobs, 15; number of rock bits used, 54; casing schedule, 12⅜-in., 250 ft.; 8⅝-in., 4000 ft., and 5½-in., 6830 ft.

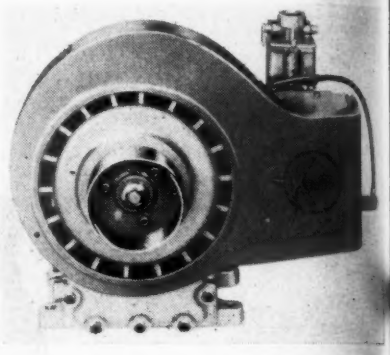
BUY WAR BONDS

(9) *Small engine*

A 5-hp. all-purpose air-cooled engine that embodies principles that are new in small engine design and manufacturing, has been announced by Kinner Motors, Inc., Glendale, California.

Called the "Busy Bee," the Kinner model AB-3 is an air-cooled, 4-cycle, L-head engine rated 5 hp. at 2600 r.p.m., but develops 6 hp. at 3250 r.p.m. The single cylinder is horizontal and detachable, making maintenance easier. Bore is 2¾ in., stroke 3 in., displacement 17.8 cu. in. The entire unit requires only 2.4 cu. ft. of space.

The "Busy Bee" is said to be the lightest engine on the market in its horsepower class. This is due to aluminum alloy used in crankcase, piston, head,



and crankcase and rear cover. Light weight of the unit provides improved cooling and is attractive to equipment manufacturers who are building portable units. Power take-off shaft is of 1 in. diameter, and rotates counterclockwise facing the shaft.

Torque curve on the engine is practically flat, demonstrating its ability to "lug" under heaviest load conditions. Bearing surfaces are large, with bearing pressures kept low. Full pressure lubrication is supplied by a positive, high pressure oil pump. All bearings are hardened to give longer wear.

(10) *Square frame welder*

Providing larger capacity in a square frame welder, P&H engineers have introduced the new Model WA-300, which has a WSR (welding service range) rating of from 60 to 375 amp. Retaining the simple, compact design of the smaller square frame welders, the large model also retains the two-part construction, single heat control, visual current calibration, and adaptability to parallel operation where higher amperage is desired.

Appearing for the first time in the Model WA-300 are such new features as weatherproof construction, polarity reversing switch, and removable stator, plus overload protection both for contacts and for the new low-voltage magnetic starter, according to the manufacturer, Harnischfeger Corporation, Welding Division, Milwaukee, Wis.

THE HUNT Wire Line Core Barrel is especially adapted to service outside the United States because manufacturer's service men are not always available, and this barrel's simplicity permits repair or replacement right on the job by field crew. It has less parts and threaded connections than any other wire line barrel . . . therefore less trouble to keep in continuous operation.

Specify, especially for export, the Hunt Wire Line Barrel that so many U. S. operators have made standard coring equipment.

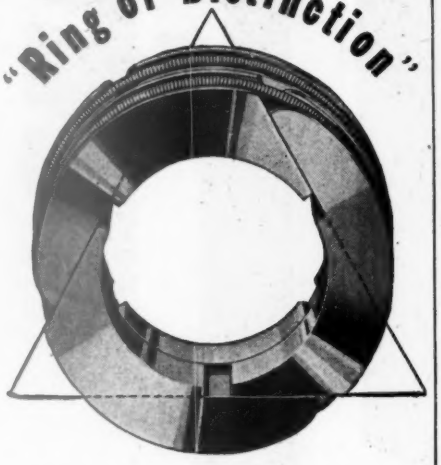
HUNT TOOL COMPANY

FIELD SHOPS: Houston, Bay City, Corpus Christi, Jennings, Harvey, Casper

EXPORT: Hunt Export Company, 19 Rector St., N. Y. C.

FOR THE DEFENSE OF DEMOCRACY
THE BEST IS NONE TOO GOOD

FRANCE PACKING
has a
"Ring of Distinction"



Imitated but never duplicated, the France ring is manufactured in three sections. The contacting faces form the lines of an equilateral triangle. As the ring is expanded or contracted, the sections must move in or out radially equal distances from the center of the rod to which the ring is fitted. This fundamental mechanical principle accounts for the efficiency, trouble-free performance and extra-long life of France Metal Packing.

After years of service, when the rings have become worn to such an extent that the sections nearly butt together, further years of additional service can be obtained by cutting off the narrow points of the three sections where they form a part of the inner circumference of the ring. The spring then requires adjustment so that the sections are held to the rod with a slight tension.

For installation in engines, pumps and compressors—under all conditions of service, France Full-floating Metal Packing means true economy in the long run.
Permit France Engineers to analyze your packing requirements.

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Original FRANCE METAL PACKING

(11) *Air foam smothers tank fire*

The effectiveness of newly developed fire fighting equipment was demonstrated recently before naval, military, and government officials when a 93-ft. tank of flaming crude oil that had reached a temperature exceeding 2000°F. was extinguished in exactly 4 min. 2½ sec. The event took place at the Moorhead tank farm of the Standard Oil Company of Ohio near Findlay, Ohio. The record-breaking result was accomplished by air foam developed by the Pyrene Development Corporation of Newark, New Jersey.

where air was introduced into the mixture of water and compound. Used in proportions of one part of foam compound to approximately 20 parts of water, the mixture expanded to about 320 gal. of foam per gal. of compound. Pouring from the applicators installed at the top of the tank, the foam flowed down the inside of the tank shell to spread in a thick blanket over the surface of the oil and smothered the flames.

R. T. Henderson, in charge of safety for the Standard Oil Company of Ohio,

A test fire is set in a tank of crude oil, temperature reaches 2000°F.

A layer of foam completely blankets the crude.

Crude oil was pumped into the tank, a torch was applied and, in about 30 sec., heat recording instruments showed that the temperature had risen to more than 2000°F. The blaze was permitted to build up for nearly 4 min., then air foam was pumped into the tank at a rate of about 15,000 gal. per min. from the applicators of a new auto-induction system developed by Pyrene. The fire was promptly controlled, and, at the end of 4 min. 2½ sec. was officially declared out.

The foam compound was contained in 55-gal. steel drums, from which suction lines fed into water pipes. These pipes carried the foam compound to foam makers on the outside of the oil tank,

supervised the tests. Among those in attendance were representatives of the Provost Marshal General's Office, the Engineer Board, Army Air Corps, Bureau of Ships, Bureau of Yards and Docks, Bureau of Aeronautics, Coast Guard Port Security, the Rubber Reserve Corporation, the Petroleum Administration for War, and officials of a number of oil, rubber, chemical, and insurance companies.

The equipment and compound that made possible the control of fires such as those set at the Moorhead tank farm can be used to protect flammable liquid hazards in a variety of industries, according to C. G. Durfee, president of the Pyrene Development Corporation.

WHEREVER oil field drilling equipment is in use, you will find that Emsco products stand out because of the long life and superior performance built into them. For example, let's look at Emsco Crown and Traveling Blocks.

In the design of these blocks, substantial savings in weight have been accomplished. Yet, because of patented features, the dropping speed of an empty Emsco Traveling Block is faster than blocks of conventional design. The sheave bearing design was developed to take care of the end thrust, each sheave and bearing being independently mounted on the shaft. This construction results in a safe, strong, narrow block. These are only a few of the characteristics which make Emsco Crown and Traveling Blocks desirable for all drilling requirements.

ARMY E NAVY

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LIMIT PLUGS

The superiority of Robinson products is reflected in our LIMIT PLUG—built with ample water courses to withstand high pressures—and constructed to accommodate large expansions...plus these features:

- Cypress wood construction
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TULSA, OKLAHOMA
Factory: Coffeyville, Kansas

(12) *Technique for enlarging storage tanks*

A new method whereby liquid storage tanks may for the first time be enlarged to as much as twice initial size without dismantling the original structure has been developed by the Stacey Bros. Gas Construction Company, Cincinnati, one of the Dresser Industries.

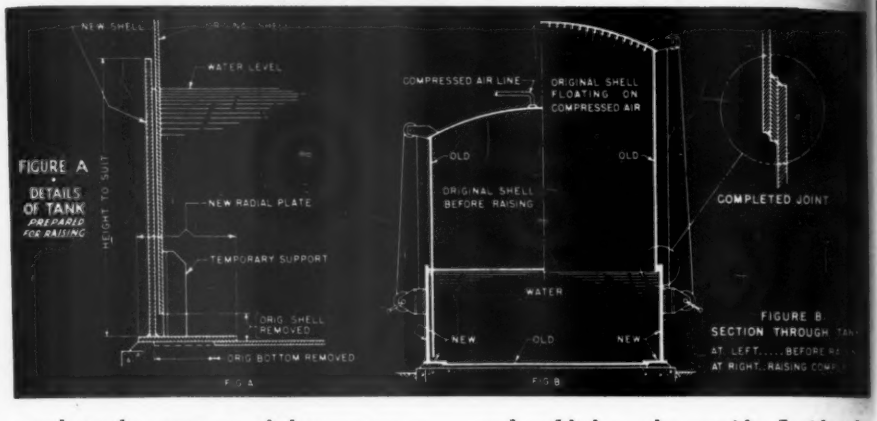
The old tank is literally boosted to new capacity height as new rings are added to the base by a patented process that makes use of virtually all the original structure in assembled form. Such reuse, along with the utilization of the original foundation and the minimum dislocation of connections, contributes much to the economy of the process as well as to the speed with which a job may be completed.

Providing for the first time an alternative to new tank construction to increase storage capacity, the Stacey Bros. method will be particularly useful where facilities are crowded and there is room only for expansion upward.

As much as 100 per cent additional capacity may be added by Stacey men, who cut the existing tank shell at the base, add new radial plates, and build a new shell around the old structure to give the desired height. Water is then run into the tank up to the new shell level, so that compressed air may be introduced to float the old cover shell up to the new level. Various controls hold the tank steady and level to 1/16 in. while 4-in. filler plates are inserted between the shells, and the two units are tack welded in place.

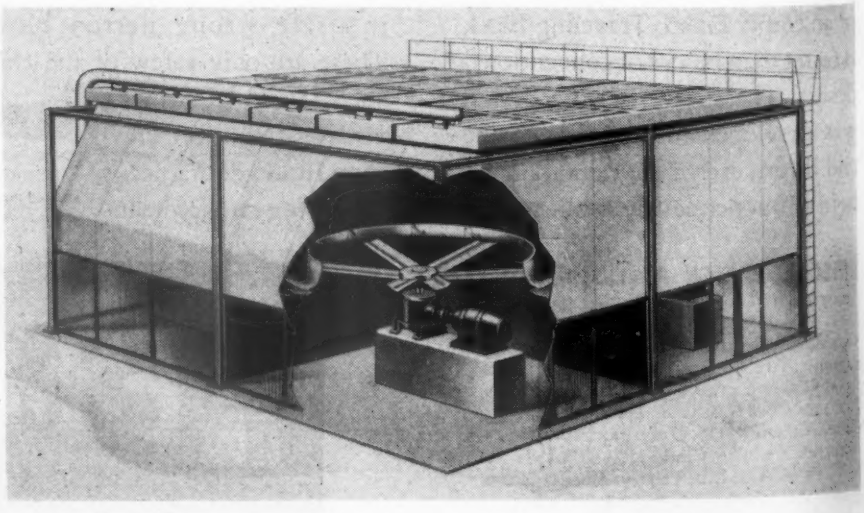
When air pressure is released, and the water drained from the tank, the two shell sections and fillers are completely seal welded on the outside. Inside, the old shell is trimmed and welded at intervals around its circumference, and the enlarged tank is ready for connections and service.

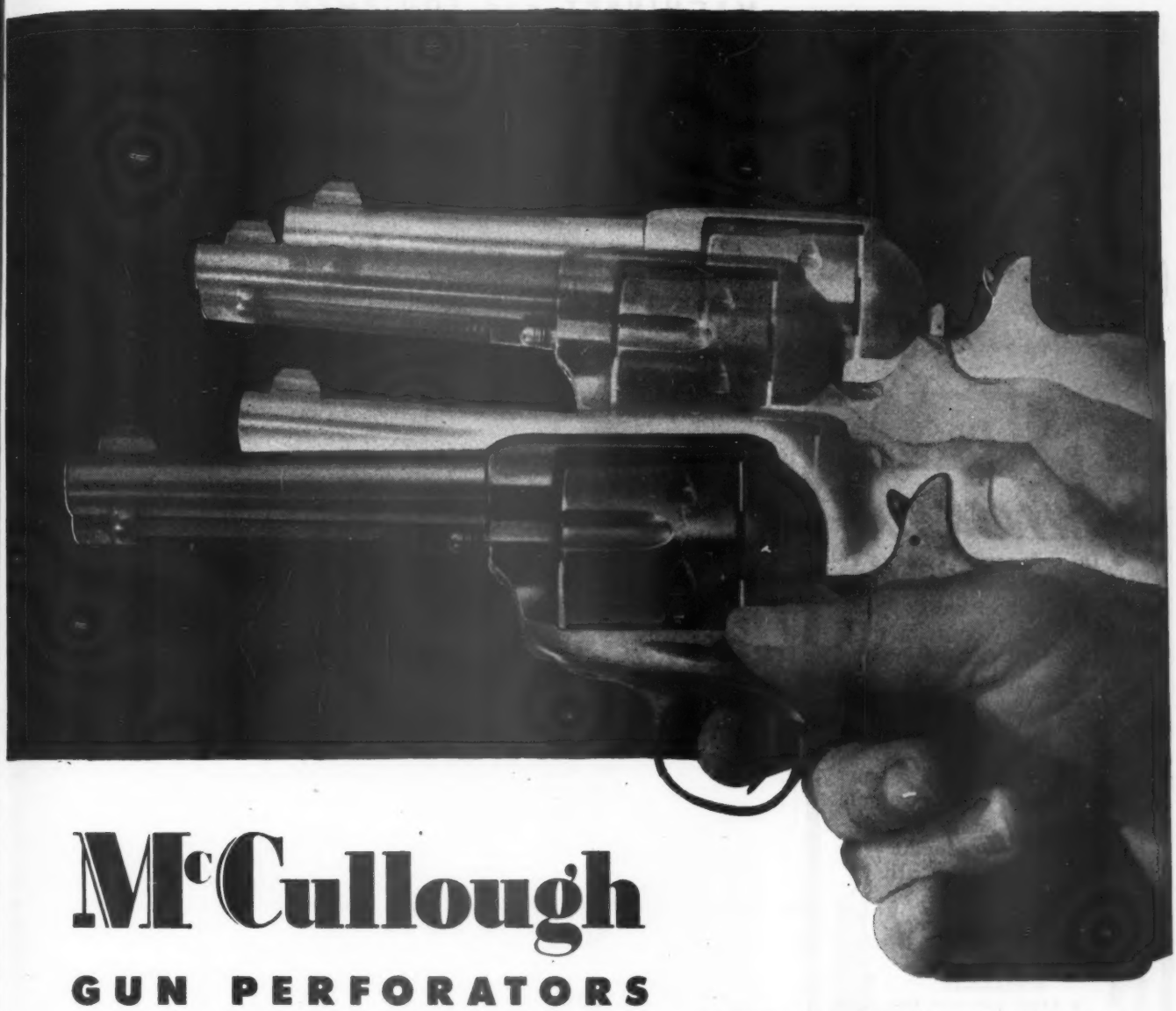
Originally developed to obtain better buoyancy control of petroleum storage tanks in areas subject to flood, the new method can be used to build up tanks having either umbrella type roofs, or roofs supported by center columns.



(13) *Fin Fan cooling unit*

Cooling sections employing the highly efficient K-fin tube construction are cooled by forced draft fed by air from the cooler layer at ground level and supplied by fans with variable pitch blades and with variable speed drive. Vertical air flow against static head assures even air distribution over cooling surfaces. Fin Fan units are designed for pressures to 5000 lb. per sq. in. and temperatures to 1500°F. Coils are placed to provide sufficient static head for pump suction. Tubes can be removed and replaced quickly and all mechanical equipment is readily accessible from the ground. The Fin Fan unit embodies the combined experience and engineering skill of The Griscom-Russell Company and The Fluor Corporation, Ltd.





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PUT THE SHOTS WHERE YOU WANT THEM

The McCullough Gun Perforator will give you a better job . . . firing all shots simultaneously while the gun is at rest in the **exact** location you want. It stands to reason — and is proved in practice — McCullough puts the shots where they count!

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VICTORIA, TEXAS	McALLEN, TEXAS	HOUMA, LA.	CASPER, WYO.	AVENAL, CALIF.
CORPUS CHRISTI, TEXAS	ALICE, TEXAS	LAKE CHARLES, LA	LOS ANGELES, CALIF	SACRAMENTO, CALIF.
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NOW I ASK YOU-

- Do you really believe I am the proper person to do this sort of work? I do not!
- In fact, I am just about as efficient at this as the average sand pump or clean-out bailer is at cleaning out an oil well.
- Confidentially, if you want a real clean-out tool go to your nearest supply store and order the tops among all clean-out tools . . .

"THE MIDCO BAILER"

- Every individual feature of the MIDCO contributes in some degree to the almost unbelievable results obtained.
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- Distributors located in practically all fields make replacement parts readily available.
- G-TYPE has solid steel plunger rod—exceptionally sturdy construction throughout.

Standard cable tool pin permits Jars and Sinker to be run above pump, eliminating fishing jobs.

- F-5 TYPE has patented plunger construction to assure highest possible efficiency in this type of pump.

PATENT No. 2061486
2090055 — 2090200
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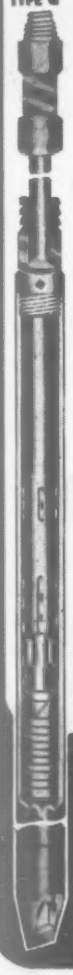
Other Patents Pending

TYPE-G TYPE F-5



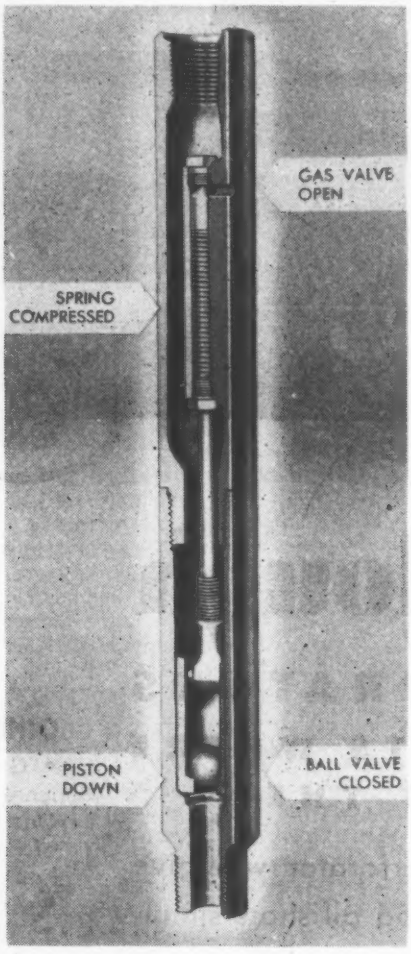
For additional information see COMPOSIT CATALOG, Page 1903
Call, wire or write

MIDCO BAILER CO.
1006 - 1012 S. E. 29th STREET
TELEPHONE 7-8586 BOX 1542
OKLAHOMA CITY - OKLAHOMA

(14) *Surge pump*

Distribution of the Baldwin-Dresser Surge Pump has been announced by the Dresser Manufacturing Division of Bradford, Pennsylvania, one of the Dresser Industries. The efficiency and ease of operation of the pump have been proved by field tests over a period of several years, the manufacturer states.

Depending on field conditions, gas pressure, and well depth, field tests have shown that the ¾-in. size of the B-D Surge Pump can easily handle 30 to 40 bbl. of water per day; the 1-in. size has a capacity of 80 to 100 barrels, whereas the 2-in. size can raise as much as 600 bbl. a day.



The spring is shown compressed by the weight of the column and the gas valve open. When liquid in the column is sufficiently aerated, the spring expands closing the gas valve. The ball valve at the bottom then opens permitting the entry of more liquid.

Operation is simple and entirely automatic. To start the B-D Surge Pump requires only the opening of a small valve at the wellhead; closing the valve, stops it. Referring to the accompanying illustration, it can be seen that when the gas valve is open, the water inlet at the bottom is closed. Gas from the casing enters the gas valve and utilizes the well-known principle of the aerated siphon in step with a surge recurrently induced in the siphon line. Pressure in the column is reduced, expansion of the spring closes the gas valve, the ball valve opens, and more liquid is admitted. This cycle repeats many times per minute, the number being dependent on well depth and gas pressure. The gas flow is interrupted at the start of each liquid surge. The surge is trapped at its maximum height, and at that instant the gas inlet is reopened.

By limiting the period of gas flow into the siphon tubing to the moment a maximum column of liquid is trapped in the tube above the Baldwin-Dresser Surge Pump, the velocity of the gas flow is retarded. This increases lifting efficiency by reducing frictional resistance between the fluid and tube. The lower gas velocity further increases efficiency by allowing more time for greater isothermic expansion of the gas before it finally escapes from the siphon line.

This simple, yet efficient, surge pump operates at a remarkably low gas liquid ratio. The low ratio is uniform, showing almost no change as the liquid level in the well falls. Field tests have shown ratios as low as 127 cu. ft. of gas per bbl. of salt water pumped from a 950-ft. well.

The B-D Surge Pump, maintains lifting efficiency without lowering the siphon line as the liquid level falls, thereby permitting installation at a much higher point in the siphon line (as high as one-fifth of total well depth) than the gas inlet ports of an ordinary siphon installation, according to the manufacturer.

Made entirely of acid-resisting bronze, the few moving parts are enclosed in a working barrel that is connected into the siphon line. There are no sucker rods, cables, or other moving connections to the wellhead.

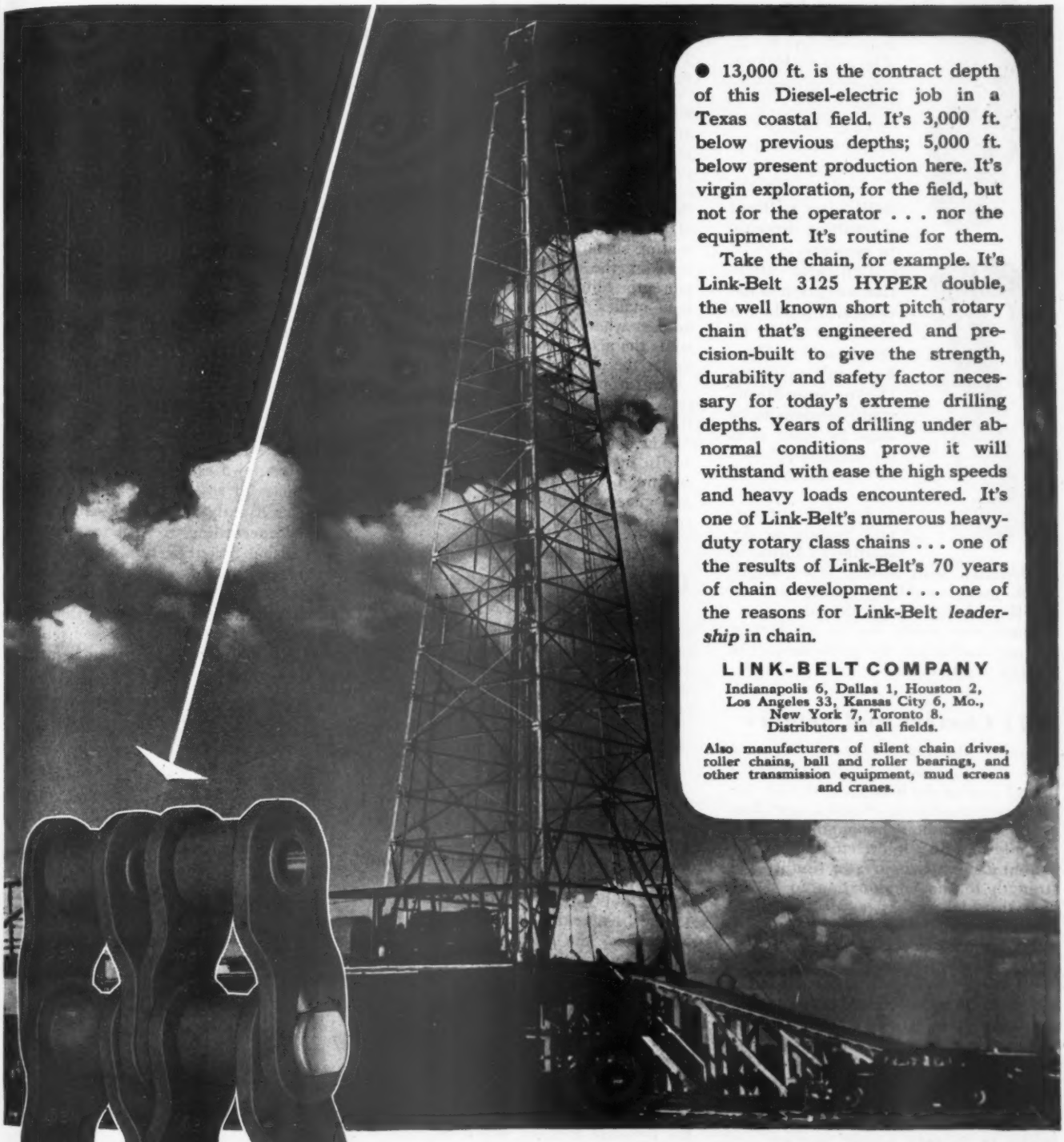
(15) *Wire belt hooks*

The Bristol Company, Mill Supply Division, Waterbury 91, Connecticut, recently announced the addition of a line of hinged-type wire belt hooks, known as Bristol's Belt Hooks, to its line of belt lacing products. The new hooks are designed for joining all types of flat belting, including leather, fabric, rubber, and balata belts. Various sizes are offered to take care of belts up to ⅜ in. thick.

A new method of mounting the hooks in the spacer card makes it possible to leave the card in place in the lacing machine during the lacing operation. The hooks are thus held in accurate alignment until the hook points pierce the belt. It is not until after the lacing operation has been completed that the card is removed. This method of carding insures a uniform spacing of the hooks and results in an even distribution of pull over the width of the belt.

The hooks are designed in such a way as to enter the belt in two rows with each opposite point passing into the belt in alternate rows. The purpose of this arrangement is to eliminate interference between opposite hook points as they are pressed into place and also to distribute the grip on the end of the belt over a greater area.

LEADERSHIP FOR 70 YEARS IN CHAINS



● 13,000 ft. is the contract depth of this Diesel-electric job in a Texas coastal field. It's 3,000 ft. below previous depths; 5,000 ft. below present production here. It's virgin exploration, for the field, but not for the operator . . . nor the equipment. It's routine for them.

Take the chain, for example. It's Link-Belt 3125 HYPER double, the well known short pitch rotary chain that's engineered and precision-built to give the strength, durability and safety factor necessary for today's extreme drilling depths. Years of drilling under abnormal conditions prove it will withstand with ease the high speeds and heavy loads encountered. It's one of Link-Belt's numerous heavy-duty rotary class chains . . . one of the results of Link-Belt's 70 years of chain development . . . one of the reasons for Link-Belt *leadership* in chain.

LINK-BELT COMPANY

Indianapolis 6, Dallas 1, Houston 2, Los Angeles 33, Kansas City 6, Mo., New York 7, Toronto 8. Distributors in all fields.

Also manufacturers of silent chain drives, roller chains, ball and roller bearings, and other transmission equipment, mud screens and cranes.

9885

LINK-BELT CHAINS . . . *a Type for Every* OIL INDUSTRY SERVICE

(16) *Tool joint*

An improved 2⅜-in. internal upset tool joint, developed by the George E. Failing Supply Company, Enid, Oklahoma, and Houston, Texas, for geophysical drilling where the outside diameter must be held to a minimum for small holes, has been announced by E. L. Alexander, chief engineer for the company.

The improved joint permits a larger stream of water to flow through the drill pipe without a resulting decrease in pressure.

Particular attention was given in the design to produce a joint that could be "made up" or "broken out" easily so these operations could continue to be done by hand as is the common practice in exploration drilling.

Another important feature is the modified V-thread in combination with a new taper angle, which makes stabbing easier, because it will not hang or cross-thread.

These new joints are in production and are available to the trade subject to priority regulations.

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(17) *Chasers and holders*

Landis Machine Company, Waynesboro, Pennsylvania, manufacturers of thread cutting die heads and thread cutting machines has developed a new chaser and chaser holder combination that not only simplifies interchanging of chasers but also imparts greater rigidity and strength to the combination to assure finer thread accuracy, according to the manufacturer.

The new Lanrac chaser and holders, as the name implies, employ a rack tooth arrangement to locate quickly the chaser in its approximate position. The chaser has rack teeth milled for its full length on the off-set seating surface, and likewise rack teeth are milled on the chaser clamp at the end nearest the chaser cutting edge. When interchanging chasers, the chaser is placed on the holder in its approximate position and clamped lightly. An adjusting screw that engages the back end of the chaser clamp is then employed to advance the chaser and chaser clamp as a unit to the exact position. Elongated slots in the chaser clamp permit sufficient lateral movement of the clamp slightly greater than the pitch of the rack.

Heretofore a plain clamp has been employed to engage the dovetail seating surface of the chaser, the chaser being backed up by an adjusting screw so situated in a tapped hole in the chaser holder as to engage the corner of the chaser at the back seating surface. This arrangement made it necessary to back up the adjusting screw as much as 2½ or 3 in., on some sizes of heads, when a long chaser was used to replace a short dull chaser. With the new clamping arrangement it is not necessary to adjust the screw more than two or three turns at any time thus saving considerable time in interchanging chasers.

In addition to permitting quicker interchange of chasers the Lanrac holders and chasers provide finer accuracy and greater strength, for the chaser has approximately 40 per cent increased base seating surface and the elimination of the tapped hole increases the thickness of the holder from its base to the base seating surface of the chaser without increasing the overall thickness. Furthermore, the elimination of the open tapped hole makes for easier cleaning of the holders when changing chasers and prevents the accumulation of chips and dirt under the clamping surfaces.

Lanrac chasers can be used with old type chaser holders, without the use of the Lanrac type clamp. All new Landis die heads employing standard chasers 15/16 in. and wider will eventually be equipped with this new chaser holder and chaser combination on which patents have been granted.

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(18) *All-green rope*

Wire rope that is entirely covered with a green-colored lubricant has recently been announced by the American Chain and Cable Company, Bridgeport, Connecticut, for its two wire rope divisions, the American Cable Division and the Hazard Wire Rope Division. Only the highest grade rope (preformed of improved plow steel) will be so lubricated. The company's non-preformed ropes made of improved plow steel will continue to be identified by a single green stand.

American Chain and Cable has long identified its ropes made of improved plow steel with a single green-colored strand. Emerald-green having been adopted as the ACCO color, American Chain and Cable established a formula for a lubricant colored green for use as its identifying strand.

American Chain and Cable's "Green-Lube" has high viscosity and remarkable capacity for adhesion to the surfaces of the wires. It has a grease-like consistency at normal temperatures and is applied hot and in a molten state by the pressure method, which not only assures complete coverage of every wire but the filling or "stuffing" of the voids between wires, it is asserted. Thus it better protects the wires, enables them to adjust themselves more easily, adheres to the wires longer and thereby develops longer rope wear, the manufacturer states.

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(19) *Thin-wall tubing*

The problem of manufacturers for the postwar era is to find applications for wartime developments. A typical example is a new ultra-thin-wall seamless tubing announced recently by North American Philips Company, 100 East 42nd Street, New York, New York.

While working on important material for the armed forces, engineers in the company's wire division accidentally learned how to produce seamless tubing of various diameters with walls of only 0.0001 to 0.001 in. thickness.

The ultra-thin-wall tubing can be made of gold, silver, copper, nickel, chromium, and other metals. It is uniform in thickness and is absolutely air-tight.

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(20) *Ionization gage*

The Precision-Televac ultra vacuum gage, known as Type E-31, is the result of years of research to eliminate deficiencies usually associated with this type gage, according to the manufacturer, Precision Scientific Company.

Electrical leakage is completely eliminated and, when used with a moderately high speed pumping system, this ionization gage actually outgasses itself, it is stated. Filament is protected before and during operation automatically in that current will not enter filament before pressure of 1 micron has been established and turns off automatically if pressure rises above 1 micron.

Gages are interchangeable without recalibration and guaranteed for 1000 hr. Standard E-31 ionization gage comes on scale at 0.4 micron (4×10^{-4} mm. Hg). The ionization gage is used with the Televac type "S" recorder.

BUY WAR BONDS

WHY A CUMMINS DIESEL ?..

In making a decision on the diesel you'll want for your new rig, consider *all* the "angles" . . . the men who build it . . . use it . . . service it.

More than 26 years of manufacturing experience devoted wholly and exclusively to diesels are represented in the modern Cummins Dependable Diesel . . . your assurance of the most advanced design and construction.

The list of Cummins Diesel owners includes many of the best-known and most successful drilling contractors and operators in the petroleum industry . . . your assurance that Cummins Diesels have long been doing the very job you want done.

Cummins Dealers provide complete service facilities in every producing area. They know the engine and are equipped in every way to take care of it . . . your assurance that your Cummins Diesels will never be far from competent *Cummins Service.*

Built by men who are *diesel specialists* . . . the choice of men who demand the best in power . . . backed by dealers who fully appreciate the importance of service . . . these are the reasons why Cummins Dependable Diesels are your most profitable investment in power.

CUMMINS ENGINE COMPANY, INC., COLUMBUS, INDIANA

TRADE LITERATURE

Publications listed are sent free upon request.

(21) *Safety controls for engines*

Penn Safety Controls for Engines is the title of Bulletin E-100B, published by the Penn Electric Switch Company, Goshen, Indiana. The bulletin is concerned with safety controls that protect engines from damage caused by failure of lubricating oil pressure, overheated bearings, or cooling water failure. By warning of such conditions a relatively simple fault can be discovered and corrected before damage and serious delay in operation occur.

(22) *Welding ideas*

"101 Welding Ideas for Low-Cost Maintenance" has been reissued by The Lincoln Electric Company, Cleveland, Ohio. In this latest issue the contents have been quite materially revised, although, as the title reveals, ideas for maintaining equipment by means of welding is still the main theme.

(23) *Fairbanks-Morse pumps*

Two new bulletins have been released by Fairbanks, Morse and Company. One describes the Figure 6920 oil lubricated turbine pump and is known as Publication AQB400. The other is about the low-lift large capacity line of pumps known as the Fairbanks-Morse Niagara Propeller Pumps. This bulletin is designated as AQB500.1.

(24) *Pressure welding pipe lines*

Amply illustrated and completely described in a recent bulletin is the method of pressure welding pipe lines. The bulletin is published by Pressure Weld Company, 421 Niels Esperson Building, Houston, 2, Texas.

(25) *National Micro-chokes*

National Micro-chokes, manufactured by The National Supply Company, Pittsburgh, Pennsylvania, are the subject of a new bulletin. Described and illustrated are the Type D and the Type E chokes. The Type D Micro-choke has its principal field of application on high pressure wells. It is constructed in a manner to permit conversion from an adjustable choke to a replaceable flow bean type. The Type E is generally supplied where an adjustable choke will be used throughout the life of the well and does not provide for replacement of the choke seat with a solid flow bean.

(26) *Jobs for war disabled*

Jobs for the War Disabled is the subject of a pamphlet published for free distribution by The American Veterans Association, 271 Madison Ave., New York, 16, New York. It deals with the placement of war disabled veterans in suitable jobs and specifically mentions the petroleum industry.

(27) *Metal-asbestos gaskets*

Condensed catalog-type folder offers construction details and specification data for Ajax spiral wound gaskets. These include boiler handhole, manhole, tubecap, and other boiler accessory gaskets; self-centering gaskets; flange gaskets with solid steel reinforcing ring; manhole gaskets with wire guide; pressure groups up to 3500 lb. per sq. in. The manufacturer is U. S. Gasket Company, 1754 Pierce Avenue, Camden, New Jersey.

(28) *Spectrometer for industrial research*

A new 8-page illustrated booklet describing the "Geiger-Counter Spectrometer For Industrial Research" has been announced by North American Philips Company, Inc., 100 East 42nd Street, New York. Written by H. Friedman of the Naval Research Laboratory for one of the trade magazines, the article has been reprinted in booklet form by permission of the Navy Department.

The author discusses in detail the theory underlying X-ray powder diffraction, how the Norelco Spectrometer works, its performance and applications. Photos, diagrams, and curves are used to illustrate the text matter. Geiger-counter tubes, circuits and losses are covered at some length by the author, and an explanation is given of the "flip-flop" counting action.

(29) *Non-magnetic manganese steel*

"Non-Magnetic Applications for Amsco Manganese Steel" is the title of a comprehensive work published on that subject; a 32-page illustrated bulletin issued by the American Manganese Steel Division of American Brake Shoe Company, Chicago Heights, Illinois.

Austenitic manganese steel is an inexpensive but very strong and tough material for castings that must be substantially non-magnetic. Its permeability is so low that the attraction by a magnet is minute and generally is not detectable.

Presented in this bulletin are studies with illustrations of typical applications where non-magnetism and the ability to withstand shock and wear were equally vital factors in the selection of manganese steel. These studies may point the way to the solution of many problems. The story of manganese steel and the company's research facilities are also covered in Bulletin 1144-NM.

(30) *Valve bulletin*

An instructive manual designed to guide users of Nordstrom valves in the proper methods and routine of lubricating plug valves has been issued by Merco Nordstrom Valve Company. The bulletin illustrates each type of valve, revealing the operation and gives plain, specific directions how to lubricate, when, and the type of lubricant best suited for specific services. Twenty-four groups of valve parts are illustrated so that the user may select replacements. Grease gun lubrication is also discussed. The bulletin will serve as a convenient reference for servicemen, plant operators, and others responsible for efficient valve operation.

(31) *Gas testing apparatus*

The Refinery Supply Company, Tulsa, Oklahoma, has available a new catalog No. 30A on gas testing apparatus. It fully describes such equipment as recording gravitometer, gas gravity balances, dew-point tester, vapor pressure bomb, specific gravity bomb, dead weight testing instruments, pulsameter, etc., giving specifications and prices.

(32) *Rex chain belt*

Bulletin No. 461, a 4-page folder on Rex Table Top Chain Belt, has been published by the Chain Belt Company, Milwaukee, 4, Wisconsin. The leaflet pictures and describes this new flat-top conveyor chain. It shows the outstanding points in construction.

(33) *Corrosion retarding units*

Baroid Sales Division of the National Lead Company, 830 Ducommun Street, Los Angeles 12, California, has published a new booklet on "Electrolytic Corrosion Retarding Units." This booklet describes in detail a practical and effective method of protection against electrolytic corrosion for pumping oil wells, oil field wash tanks, and other tubular installations. Also described are units for large non-tubular structures such as ships and storage tanks. Other factors, such as protection against internal and external corrosion, are also covered.

(34) *Rotary drilling hose*

Details of construction of each of its four lines of rotary drillers' hose, together with a table showing comprehensive data on each, are contained in the new catalog section on the subject issued by The B. F. Goodrich Company, Akron, Ohio.

Leader in the B. F. Goodrich line is the Super-Hipress, made with 9 plies of extra strong hose duck and 3 plies of metallic mesh tape at correct crossed angles to control pressure, together with a ply of solid round wire under the cover to provide additional resistance to crushing and kinking. Test pressure on delivery is 5000 lb. per sq. in.

Other hose in the line include the Hi-Press, 4000 lb. initial test pressure on delivery; the Akron, 2000 lb. per sq. in., and the Pinnacle, for shallow well drilling.

(35) *Instruments and controllers*

A handcome new booklet has been released by the Hays Corporation, Michigan City, Indiana, manufacturers of combustion instruments and controls entitled "Hays Instruments and Controllers in Industry." It features schematic drawings of typical applications of instruments and controllers to the following industrial control problems: Pressure reducing, pressure relief or back pressure, rate of flow, turbine-driven compressor control, and control of speed, liquid level, and liquid density.

THE *Petroleum* Engineer's CONTINUOUS TABLES

A DAILY REFERENCE FOR OPERATING MEN

INSTALLMENT NO. 96

A VALUABLE and regular feature of *The Petroleum Engineer*, the Continuous Tables, now in their seventh year of publication, were designed to save time and effort for the technician and the practical field or plant worker. The tables have proved one of the most popular and helpful departments of *The Petroleum Engineer*. Data are presented in the simplest form available with many types of information included that are best presented by curves or nomographs when three or more variables must be considered simultaneously.

The Continuous Tables have developed as a result of suggestions for new tables, direct contributions, and improvements to existing tables by members of the petroleum and related industries, including manufacturing concerns, who are continually searching for practical information reduced by computation to tabular form readily applicable to the problems daily confronting them that might otherwise necessitate a more or less tedious calculation. These contributions and suggestions from the industry have resulted in a valuable exchange of information and data contributing to the progress of the industry as a whole.

This index will be revised monthly. The index for installments 1-12, inclusive, will be found in the May, 1938, issue; 13-24, inclusive, in the June, 1939, issue; 25-36, inclusive, in the June, 1940, issue; 37-48, inclusive, in the June, 1941, issue; 48-60, inclusive, in the June, 1942, issue; 61-72, inclusive, in the June, 1943, issue; 73-79, inclusive, in the January, 1944, issue; 80-82, inclusive, in the April, 1944, issue; 83-85, inclusive, in the July, 1944, issue; 86-88, inclusive, in the October, 1944, issue; 89-91, inclusive, in the January, 1945, issue, and 92-94, inclusive, in the April, 1945, issue.

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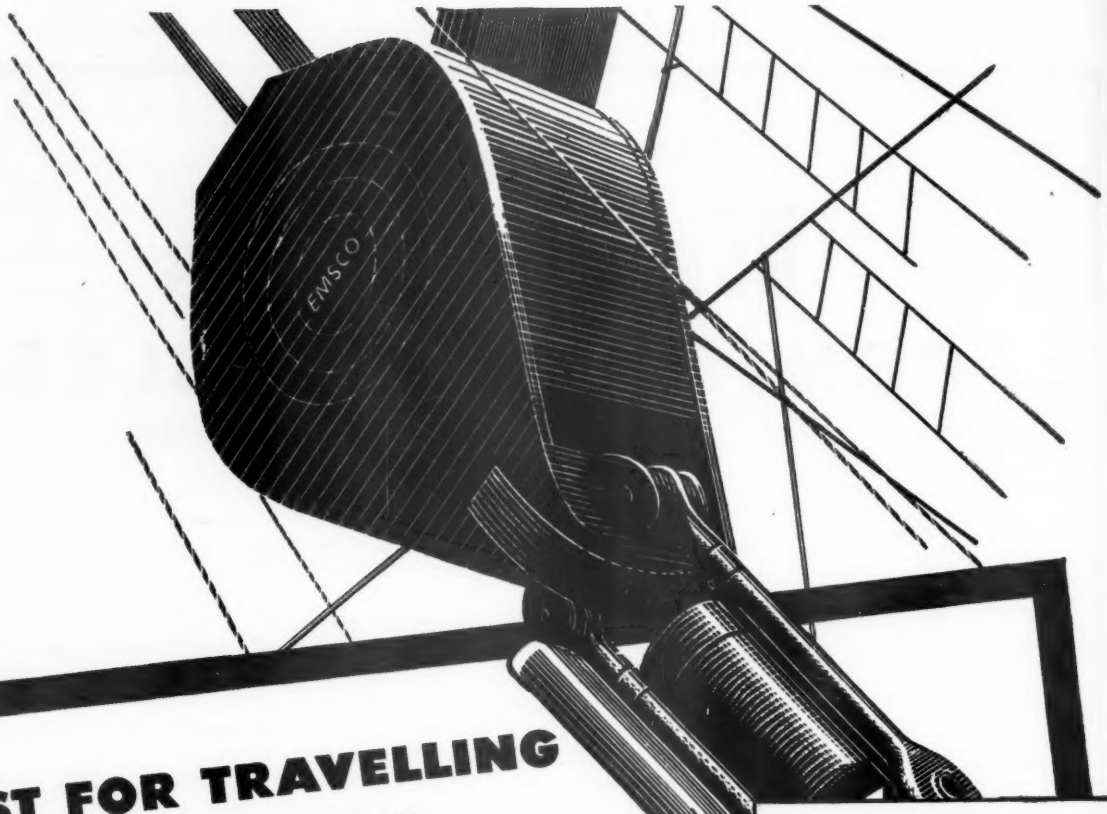


BEST FOR TRAVELLING BLOCKS, TOO

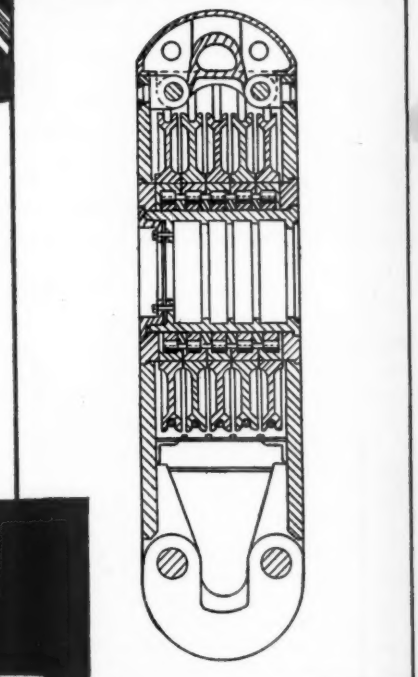
Today's military needs and tomorrow's civilian requirements indicate that "the heat will be on" in the oil fields for years to come. Thus, the call is, more than ever, for equipment that's built to "stay in there and take it"... to deliver long years of efficient, economical performance.

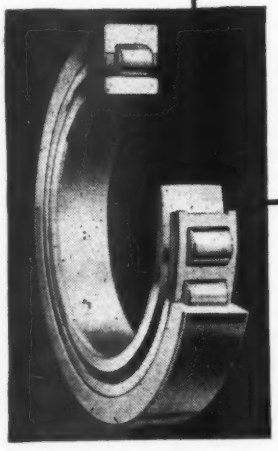
That's why you find more and more oil field machinery, like the widely-used Emsco Travelling Block shown on this page, equipped with Torrington Bearings specifically designed for high anti-friction capacity combined with economy of maintenance.

In this particular application, those twin goals are achieved by the bearing's ingenious but simple three-piece construction—separate inner and outer races and spacer plates. This enables the bearing to handle both radial loads and thrust pressures efficiently and dependably... and at the same time permits economical upkeep by *reconditioning or replacing of individual worn elements.*

Your oil field machinery should deliver that kind of efficient, economical performance in the busy years ahead. Torrington's Bantam Bearings Division will gladly work with your engineers to incorporate those and other Torrington advantages into the equipment you design, build or operate.

THE TORRINGTON COMPANY · BANTAM BEARINGS DIVISION
SOUTH BEND 21, INDIANA





Typical application of sturdy, easily serviced Torrington Roller Bearings to Emsco Travelling Block. This is one of many Torrington Bearing applications to oil field machinery.

TORRINGTON BEARINGS

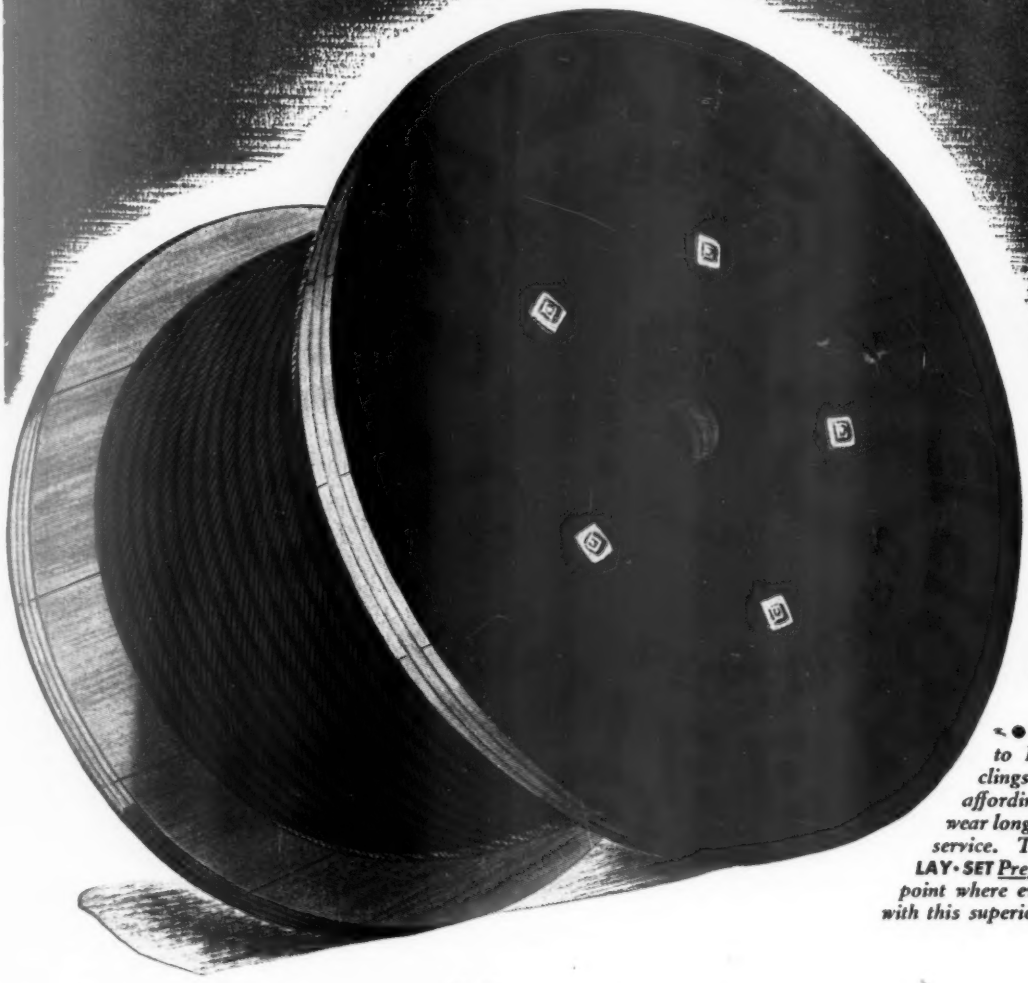
STRAIGHT ROLLER · TAPERED ROLLER · NEEDLE · BALL

GAS-OIL RATIO CONVERSION TABLE

Gas-oil ratio (cu. ft./bbl.)	Yield (bbl./MMCF)	Content (gal./MCF)	Gas-oil ratio (cu. ft./bbl.)	Yield (bbl./MMCF)	Content (gal./MCF)
25,000	40.00	1.680	70,000	14.29	0.600
26,000	38.46	1.615	71,000	14.09	0.592
27,000	37.04	1.556	72,000	13.89	0.583
28,000	35.71	1.500	73,000	13.70	0.575
29,000	34.48	1.448	74,000	13.51	0.568
30,000	33.33	1.400	75,000	13.33	0.560
31,000	32.26	1.355	76,000	13.16	0.553
32,000	31.25	1.313	77,000	12.99	0.546
33,000	30.30	1.273	78,000	12.82	0.539
34,000	29.41	1.235	79,000	12.66	0.532
35,000	28.57	1.200	80,000	12.50	0.525
36,000	27.78	1.167	81,000	12.35	0.519
37,000	27.03	1.135	82,000	12.20	0.512
38,000	26.32	1.105	83,000	12.05	0.506
39,000	25.64	1.077	84,000	11.91	0.500
40,000	25.00	1.050	85,000	11.77	0.494
41,000	24.39	1.024	86,000	11.63	0.488
42,000	23.81	1.000	87,000	11.49	0.483
43,000	23.26	0.977	88,000	11.36	0.477
44,000	22.73	0.955	89,000	11.24	0.472
45,000	22.22	0.933	90,000	11.11	0.467
46,000	21.74	0.913	91,000	10.99	0.462
47,000	21.28	0.894	92,000	10.87	0.457
48,000	20.83	0.875	93,000	10.75	0.452
49,000	20.41	0.857	94,000	10.64	0.447
50,000	20.00	0.840	95,000	10.53	0.442
51,000	19.61	0.824	96,000	10.42	0.438
52,000	19.23	0.808	97,000	10.31	0.433
53,000	18.87	0.793	98,000	10.20	0.429
54,000	18.52	0.778	99,000	10.10	0.424
55,000	18.18	0.764	100,000	10.00	0.420
56,000	17.86	0.750	105,000	9.52	0.400
57,000	17.54	0.737	110,000	9.09	0.382
58,000	17.24	0.724	115,000	8.70	0.365
59,000	16.95	0.712	120,000	8.33	0.350
60,000	16.67	0.700	125,000	8.00	0.336
61,000	16.39	0.689	130,000	7.69	0.323
62,000	16.13	0.677	135,000	7.41	0.311
63,000	15.87	0.667	140,000	7.14	0.300
64,000	15.63	0.656	145,000	6.90	0.290
65,000	15.39	0.646	150,000	6.67	0.280
66,000	15.15	0.636	155,000	6.45	0.271
67,000	14.93	0.627	160,000	6.25	0.263
68,000	14.71	0.618	165,000	6.06	0.255
69,000	14.49	0.609	170,000	5.88	0.247

Example: 100,000 cu. ft./bbl.=10.00 bbl./million cu. ft.=0.420 gal./thousand cu. ft.

Now LAY·SET PREFORMED I.P.S.* is ALL GREEN!



● *The new* GREEN LUBE, *made to Hazard's own specifications, clings to the wires better, thereby affording increased protection. Wires wear longer; the entire rope gives longer service. That is why every strand in* LAY·SET *Preformed I. P. S. is packed to the point where every void is completely filled with this superior lubricant.*

Here is the ultimate in wire rope perfection. ... Hazard LAY·SET Preformed made of Improved Plow Steel* ... every strand of which is literally stuffed with our superior green lubricant ... the best of all rope made still better by the more adhesive green lubricant which coats every wire.

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ACCO

TRADE MARK

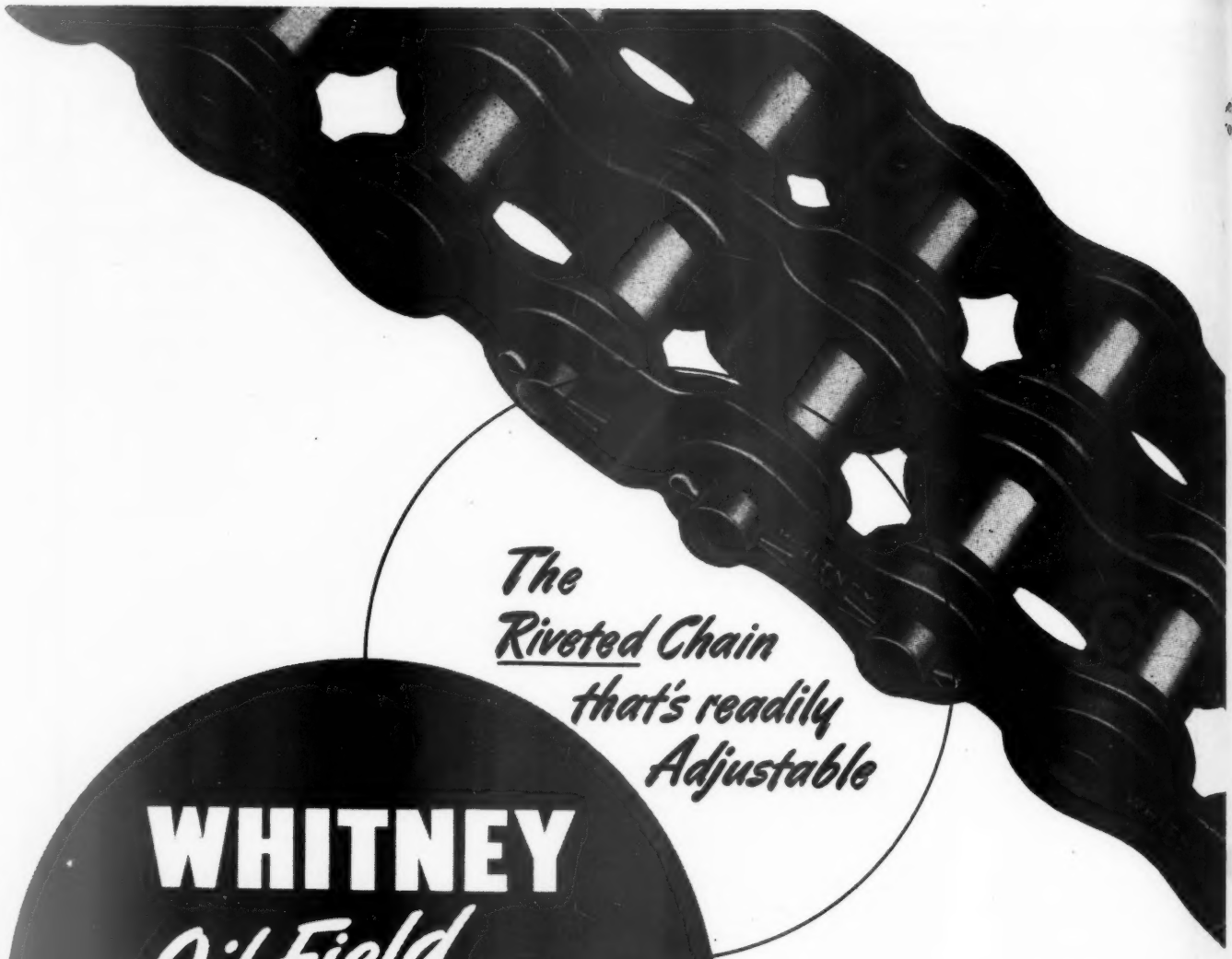
HAZARD WIRE ROPE DIVISION
AMERICAN CHAIN & CABLE

In Business for Your Safety

GAS-OIL RATIO CONVERSION TABLE

Gas-oil ratio (cu. ft./bbl.)	Yield (bbl./MMCF)	Content (gal./MCF)	Gas-oil ratio (cu. ft./bbl.)	Yield (bbl./MMCF)	Content (gal./MCF)
175,000	5.71	0.240	500,000	2.00	0.084
180,000	5.56	0.233	550,000	1.82	0.076
185,000	5.41	0.227	600,000	1.67	0.070
190,000	5.26	0.221	650,000	1.54	0.065
195,000	5.13	0.215	700,000	1.43	0.060
200,000	5.00	0.210	750,000	1.33	0.056
205,000	4.88	0.205	800,000	1.25	0.053
210,000	4.76	0.200	850,000	1.18	0.049
215,000	4.65	0.195	900,000	1.11	0.047
220,000	4.55	0.191	950,000	1.05	0.044
225,000	4.44	0.187	1,000,000	1.00	0.042
230,000	4.35	0.183	1,100,000	0.91	0.038
235,000	4.26	0.179	1,200,000	0.83	0.035
240,000	4.17	0.175	1,300,000	0.77	0.032
245,000	4.08	0.171	1,400,000	0.71	0.030
250,000	4.00	0.168	1,500,000	0.67	0.028
255,000	3.92	0.165	1,600,000	0.63	0.026
260,000	3.85	0.162	1,700,000	0.59	0.025
265,000	3.77	0.159	1,800,000	0.56	0.023
270,000	3.70	0.156	1,900,000	0.53	0.022
275,000	3.63	0.153	2,000,000	0.50	0.021
280,000	3.57	0.150	2,100,000	0.48	0.020
285,000	3.51	0.147	2,200,000	0.46	0.019
290,000	3.45	0.145	2,300,000	0.44	0.018
295,000	3.39	0.142	2,400,000	0.42	0.018
300,000	3.33	0.140	2,500,000	0.40	0.017
310,000	3.23	0.135	2,600,000	0.38	0.016
320,000	3.13	0.131	2,700,000	0.37	0.016
330,000	3.03	0.127	2,800,000	0.36	0.015
340,000	2.94	0.124	2,900,000	0.34	0.014
350,000	2.86	0.120	3,000,000	0.33	0.014
360,000	2.78	0.117	3,500,000	0.29	0.012
370,000	2.70	0.114	4,000,000	0.25	0.011
380,000	2.63	0.111	4,500,000	0.22	0.009
390,000	2.56	0.108	5,000,000	0.20	0.008
400,000	2.50	0.105	5,500,000	0.18	0.008
410,000	2.44	0.102	6,000,000	0.17	0.007
420,000	2.38	0.100	6,500,000	0.15	0.006
430,000	2.33	0.098	7,000,000	0.14	0.006
440,000	2.27	0.095	7,500,000	0.13	0.006
450,000	2.22	0.093	8,000,000	0.13	0.005
460,000	2.17	0.091	8,500,000	0.12	0.005
470,000	2.13	0.089	9,000,000	0.11	0.005
480,000	2.08	0.088	9,500,000	0.11	0.004
490,000	2.04	0.086	10,000,000	0.10	0.004

Example: 500,000 cu. ft./bbl.=2.00 bbl./million cu. ft.=0.084 gal./thousand cu. ft.



The Riveted Chain that's readily Adjustable

WHITNEY *Oil Field Assembly* CHAIN

Because of the incorporation of offset links at about 25-link intervals in Whitney Oil Field Assembly Chain, adjustments for wear and elongation may be easily made by the *removal* of one or more of the offset links. Thus, by the avoidance of *new* link replacements, equal pitch is maintained in *all* links.

The combination of FIXED SHAFT CENTERS and ADJUSTABLE LENGTH RIVETED CHAIN provides added opportunity for ECONOMICAL OPERATION.

THE WHITNEY CHAIN & MFG. CO., HARTFORD 2, CONNECTICUT

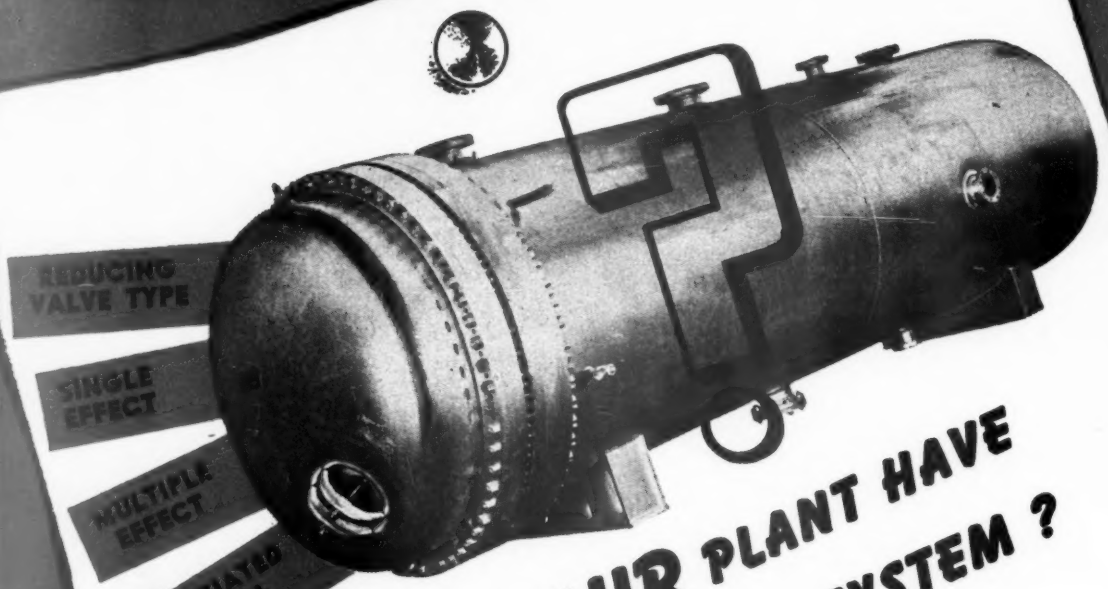
It pays to specify WHITNEY CHAINS Distributed by

THE CONTINENTAL SUPPLY COMPANY, Dallas, Texas

PROPERTIES OF FLAMMABLE LIQUIDS, GASES, AND SOLIDS

Name	Synonyms	Flash point, °F.		Explosive limits, per cent by vol. in air		Auto-ignition temp., °F.	Susceptibility to spontaneous heating	Specific gravity (water=1.00)	Vapor density (air=1.00)	Melting point, °F.	Boiling point, °F.	Suitable Extinguishing agents
		Closed cup	Open cup	Lower	Upper							
Diamyl phenoxy ethanol		....	300	....	....	....	..	0.959	9.6	-31	615	3
Diamyl phthalate		245	340	....	....	....	..	....	....	....	648	1, 2, 3
Dianisidine		403	....	....	....	....	..	....	....	269	....	1, 3
Dibenzyl ether		275	....	....	....	....	No	1.036	6.82	41	568	1, 2, 3
Dibutyl ether-n		77	....	....	....	....	No	0.769	4.48	....	286	3
Dibutyl oxalate-n		220	....	....	....	....	No	1.01	....	....	....	1, 2, 3
Dibutyl phthalate-n		315	335	....	....	....	No	1.045	9.58	....	690	1, 2, 3
Dibutyl phthalate-iso		322	....	....	....	....	No	....	9.58	....	....	1, 2, 3
Dibutyl sebacate		....	353	....	....	....	..	.936	....	....	....	1, 3
Dibutyl tartrate-n		195	230	....	....	....	No	1.098	9.03	72	650	1, 2, 3
o-Dichlorobenzene		151	165	....	....	....	No	1.325	5.07	2	354	1, 2, 3
p-Dichlorobenzene		150	165	....	....	....	No	1.458	5.07	127	345	1, 3
Dichlorodifluoromethane	Freon, F-12	non-flammable				....	No	....	....	....	-21.5	....
Dichloro ethylene 1, 1	Dichloro ethene 1, 1	57	....	5.6	13	856	No	1.250	3.35	....	98.6	1, 2, 3
Dichoro ethylene 1, 2	Acetylene dichloride	43	....	9.7	12.8	....	No	1.282	3.35	-113	141	1, 2, 3
Dichloroethyl ether-sym		131	185	....	....	696	No	1.22	4.93	-58	352	1, 2, 3
Dichloroisopropyl ether		....	185	....	....	....	No	1.113	....	....	369	1, 2, 3
1, 1 Dichloro, 1 Nitro ethane		....	168	....	....	....	..	1,405	4.97	....	255	1, 3
1, 1 Dichloro, 1 Nitro propane		....	151	....	....	....	..	1.314	5.45	....	282	1, 3
Dichlorotetrafluoroethane	F-114	non-flammable				....	No	....	....	....	38.6	....
Dicyclohexylamine		....	>210	....	....	....	..	0.910	6.27	....	496	3
Diethanolamine		....	280	....	....	1224	No	1.097	3.65	82	514	1, 3
Diethylamine		<0	<0	....	....	....	..	0.710	2.53	....	134	3
Diethylaminoethanol		....	140	....	....	....	No	0.885	....	....	322	3
Diethyl carbitol		....	180	....	....	....	No	0.908	....	....	367	1, 3
Diethyl carbonate		77	....	....	....	....	No	0.977	4.07	-45	259	2, 3
Diethyl cellosolve		....	95	....	....	....	No	0.842	....	....	251	3
Diethyl diphenyl urea		302	....	....	....	....	..	....	....	....	....	1, 2, 3
Diethylene glycol		255	290	....	....	444	No	1.119	3.66	21	472	1, 3
Diethylene oxide	Dioxan	65	....	1.97	22.2	....	..	1.035	3.03	50	214	3
Diethylene Triamine		....	215	....	....	....	....	0.954	3.48	....	404	1, 3
Diethyl ether	Ether	-20	....	1.7	48.0	366	No	0.71	2.55	-177	95	3
Diethyl glycophthalate		343	....	....	....	....	..	....	....	....	....	1, 3
p-Diethyl phthalate		243	305	....	....	....	..	1.110	7.66	112	576	1, 2, 3,
Diethyl selenide		....	....	2.5	....	....	No	1.23	4.73	....	226	1, 2, 3
Diethyl sulfate		220	....	....	....	....	No	1.184	5.31	-12	406	1, 2, 3
Diglycol chlorohydrin		....	225	....	....	....	No	1.172	....	....	387	1, 3
Dimethoxy tetraglycol		....	285	....	....	....	No	1.013	....	....	528	1, 3
Dimethyl aniline		145	170	....	....	700	No	0.956	4.17	36	379	1, 2, 3
p-Dimethyl cyclohexane	Hexahydroxylol	52	....	....	....	....	No	0.77	3.86	-123	248	2, 3
Dimethyl ether	Methyl ether	-42	....	....	....	....	No	....	1.617	-216	-11	3
Dimethyl glycophthalate		369	....	....	....	....	No	....	9.72	....	....	1, 3
o-Dimethyl phthalate		295	325	....	....	....	No	1.189	6.69	....	540	1, 2, 3
Dimethyl sulfate	Methyl sulfate	182	240	....	....	....	No	1.332	4.35	-16	370	1, 2, 3
Dimitro aniline-2, 4		435	510	....	....	....	..	1.615	6.31	370	....	1, 3
Dinitro benzene		302	....	....	....	....	..	1.59	5.79	243	605	1, 3
Dinitro chlorobenzene		382	405	....	....	....	..	1.68	6.98	109	....	1, 3
Dinitro Toluene-2, 4		....	....	....	....	....	No	1.52	6.27	158	572	1, 3
Diphenyl		235	255	....	....	....	No	1.041	5.31	158	491	1, 3
Diphenylamine		307	....	....	....	....	No	1.16	5.82	127	575	1, 3
Diphenyl methane	Ditane	266	....	....	....	....	No	1.006	5.79	79	508	1, 2, 3
Diphenyl oxide	Diphenyl ether	239	....	....	....	....	No	1.073	5.86	81	500	1, 2, 3
Dipropylene glycol		....	280	....	....	....	No	1.040	....	....	372	1, 3
Divinyl ether	Vinyl ether	<-22	....	1.7	27.0	680	No	0.774	....	....	102	3
Dodecane	Dihexyl	165	....	0.6	....	....	No	0.750	5.86	10	421	1, 2, 3
Ester gum		375	555	....	....	....	No	....	....	285	495	1, 3
Ethane	gas	gas	....	3.12	15.0	950	No	....	1.049	-278	-128	4
Ethanolamine		....	200	....	....	....	No	1.02	2.10	51	342	1, 3
Ethyl acetanilide		126	....	....	....	....	..	0.942	4.72	....	400	2, 3
Ethyl acetate	Acetic ether	24	30	2.18	11.5	907	No	0.899	3.04	-116	171	3
Ethyl acetoacetate	Acetoacetic ester	184	....	....	....	....	No	1.03	4.48	-48	356	1, 3
Ethyl alcohol	Ethanol	55	....	3.28	19	799	No	0.79	1.59	-178	173	3
Ethyl benzene	Phenyl ethane	59	75	....	....	....	No	0.868	3.66	-134	277	2, 3
Ethyl bromide	Bromoethane	....	....	6.75	11.25	952	No	1.430	3.76	-182	100	1, 3
Ethyl butyl carbonate		122	....	....	....	....	No	....	5.03	....	....	2, 3
Ethyl butyrate		78	85	....	....	....	No	0.879	4.00	-135	248	3
Ethyl chloride	Chloroethane	-58	-45	3.6	14.8	....	No	0.910	2.22	-220	54	3
Ethylene	gas	gas	....	3.02	34	1009	No	....	0.975	-272	-155	4
Ethylene chlorohydrin		....	140	....	....	....	No	1.213	2.78	-94	264	1, 3
Ethylene diamine		93	110	....	....	....	No	0.890	2.07	47	241	3
Ethylene dichloride	Dichloro ethane-1, 2	56	65	6.2	15.9	775	No	1.256	3.42	-33	183	1, 2, 3
Ethylene glycol	Glycol	232	240	....	....	775	No	1.113	2.14	3	387	3
Ethylene oxide		....	....	3	80	804	No	0.887	1.52	-168	51	3
Ethyl formate		-4	10	3.5	16.5	....	No	0.922	2.55	-112	130	2, 3

See Table P 600.11 (sheet 1) for explanation of symbols. — *Table by courtesy of Associated Factory Mutual Fire Insurance Companies.*



REDUCING VALVE TYPE
SINGLE EFFECT
MULTIPLE EFFECT
ASSOCIATED SYSTEM

SHOULD YOUR PLANT HAVE AN EVAPORATOR SYSTEM ?

ONE OF A SERIES OF ADVERTISEMENTS DESCRIBING THE MANY TYPES OF G-R HEAT TRANSFER APPARATUS

The fact that one or more of your neighboring plants do or do not have an evaporator system for distilling their boiler feed make-up may not be a safe guide for you to follow—even if these plants seem to be similar to your own.

Operating conditions, steam demands, quality of raw water supply and plant heat balance—all are factors in determining the advisability of an evaporator installation. These factors are distinctive in each plant and require individual study. Griscom-Russell brings to such a study the accumulated experience of 77 years of pioneering in the development and application of evaporator systems, and the results obtained in many hundreds of evaporator installations.

These are some of the reasons why Griscom-Russell recommendations are authoritative, and why you can depend upon their advice as to the advisability of an evaporator system for your particular plant conditions. Write for complete information, without obligation.

G-R BUILDS ALL THESE UNITS FOR HEAT TRANSFER SERVICE . . .

Evaporators
Stage Heaters
Gas Coolers
Drain Coolers
Aftercoolers
Air Preheaters
Fuel Oil Heaters
Jacket Water Coolers
Process Heat Exchangers
Transformer Oil Coolers
Generator Air Coolers
Lubricating Oil Coolers
Storage Tank Oil Heaters

THE GRISCOM-RUSSELL CO.
285 Madison Ave., New York 17, N. Y.

GRISCOM-RUSSELL
Pioneers in Heat Transfer Apparatus

PROPERTIES OF FLAMMABLE LIQUIDS, GASES, AND SOLIDS

Name	Synonyms	Flash point, °F.		Explosive limits, per cent by vol. in air		Auto-ignition temp., °F.	Susceptibility to spontaneous heating	Specific gravity (water=1.00)	Vapor density (air=1.00)	Melting point, °F.	Boiling point, °F.	Suitable Extinguishing agents
		Closed cup	Open cup	Lower	Upper							
Ethyl glycol acetate		117	....	....	....	....	No	....	4.55	....	....	3
Ethyl lactate		115	....	....	....	....	No	1.03	4.41	....	309	3
Ethyl mercaptan	Ethyl sulfhydrate	....	....	2.8	18.2	570	..	0.839	2.11	-185	98	3
Ethyl nitrate	Nitric ether	50	50	3.8	....	....	No	1.105	3.14	-152	190	2, 3
Ethyl nitrite	Nitrous ether	-31	-30	3.01	>50	....	No	0.900	2.59	....	63	2, 3
Ethyl oxalate		....	....	....	....	....	No	1.080	5.04	-40	367	1, 3
Ethyl phthallyl ethyl glycollate		365	385	....	....	....	..	>1	....	....	....	1, 2, 3
Ethyl propionate		54	....	....	....	....	No	0.891	3.52	-99	210	2, 3
Ethyl silicate		....	125	....	....	....	..	0.936	7.22	....	334	3
Ethyl p-Toluene sulfonamide		260	380	....	....	....	..	....	....	....	....	1, 3
Ethyl p-toluene sulfonate		316	....	....	....	....	..	....	....	....	....	1, 2, 3
Formaldehyde, (gas)	Methanal	....	....	....	....	806	No	....	1.03	-134	-6	3
(Soln. of gas in water)		130	200	....	....	....	No	....	....	....	....	3
Formic acid		156	....	....	....	....	..	1.218	1.59	47	213	1, 3
Fuel oil no. 1	Range oil	100-165	....	....	....	490	No	<1	....	....	....	2, 3
Fuel oil no. 2		110-190	....	....	....	494	No	<1	....	....	....	2, 3
Fuel oil no. 3		125-200	....	....	....	498	No	<1	....	....	....	2, 3
Fuel oil no. 4		150+	250	....	....	505	No	<1	....	....	....	1, 2, 3
Fuel oil no. 5		150+	....	....	....	....	No	<1	....	....	....	1, 2, 3
Fuel oil no. 6		150+	320	....	....	765	No	<1	....	....	....	1, 2, 3
Furfural		140	155	2.1	....	739	No	1.159	3.31	-36	322	1, 2, 3
Furfuryl alcohol	Furfuryl carbinol	....	....	....	....	915	..	1.129	3.37	....	340	3
Gas, blast furnace		....	....	35	74	....	No	....	....	....	....	4
Gas, coal gas		....	....	5.3	31	1200	No	....	....	....	....	4
Gas, illuminating		....	....	5.3	31	1094	No	....	....	....	....	4
Gas, natural		....	....	4.8	13.5	....	No	....	....	....	....	4
Gas, oil gas		....	....	6.0	13.5	637	No	....	....	....	....	4
Gas, producer		....	....	20.7	73.7	....	No	....	....	....	....	4
Gas, water		....	....	9.0	55.0	....	No	....	....	....	....	4
Gas oil		150+	....	....	....	640	No	<1	....	....	....	1, 2, 3
Gasoline		-50	....	1.3	6	495	No	0.75	3-4	<-50	100-400	2, 3
Glycerine	Glycerol	320	350	....	....	739	No	1.26	3.17	64	554	1, 3
Glyceryl triacetate	Triacetin	280	295	....	....	....	No	1.161	7.52	-108	496	1, 2, 3
Glycol diacetate	Ethylene acetate	....	220	....	....	....	No	1.100	4.53	-24	370	1, 2, 3
Heptane-n		25	....	1	6	452	No	0.683	3.45	-130	208	2, 3
Hexane-n		-7	....	1.25	6.90	477	No	0.661	2.97	-137	156	3
Hexyl acetate	Ethyl butyl acetate	135	....	....	....	....	No	0.83	4.97	....	290	3
Hexyl acetate	Methyl amyl acetate	113	....	....	....	....	No	0.855	4.97	....	285	3
Hexyl alcohol-n	Hexanol-n	145	....	....	....	....	No	0.82	3.52	-62	311	3
Hexyl alcohol	Ethyl butyl alcohol	137	....	....	....	....	No	0.818	3.52	....	275	3
Hexyl alcohol	Methyl amyl alcohol	114	....	....	....	....	No	0.804	3.52	....	266	3
Hydrocyanic acid		0	....	5.6	40	1000	No	0.697	0.9	10	79	....
Hydrogen		gas	....	4.1	74.2	1076	No	....	0.069	-435	-422	4
Hydrogen sulfide		gas	....	4.3	45.5	....	No	....	1.189	-117	-76	4
Hydroquinone		329	....	....	....	....	..	1.332	3.81	338	545	1, 3
Isobutyraldehyde		-40	....	....	....	490	..	.813	....	....	....	3
Kerosene	No. 1 fuel oil	100-165	....	....	....	490	No	<1	....	....	....	2, 3
Lanolin	Wool grease	460	560	....	....	833	Yes	<1	....	100+	....	1, 2, 3
Lard oil (commercial)		395	....	....	....	833	Yes	<1	....	28	....	1, 2, 3
Lead tetramethyl		....	....	1.8	....	....	..	1.995	9.20	-18	230	1, 2, 3
Linseed oil		435	535	....	....	820	Yes	0.93	....	-2	600+	1, 2, 3
Lubricating oil, cylinder		....	535	....	....	783	No	<1	....	....	....	1, 2, 3
Lubricating oil, light machine		318	370	....	....	....	No	<1	....	....	....	1, 2, 3
Lubricating oil, motor		....	450	....	....	....	No	<1	....	....	....	1, 2, 3
Lubricating oil, spindle		169	200	....	....	....	No	<1	....	....	....	1, 2, 3
Lubricating oil, turbine		....	400	....	....	700	No	<1	....	....	....	1, 2, 3
Magnesium (powder or chips*)		....	....	....	....	....	No	....	....	1200	2048	5
Manganese (powder)*		....	....	....	....	....	No	....	....	2300	3450	5
Menhaden oil		435	....	....	....	828	Yes	0.927	....	....	....	1, 2, 3
Mesityl oxide		87	....	....	....	....	..	0.858	3.40	....	266	3
Metaldehyde	m-Acetaldehyde	97	135	....	....	....	No	....	6.06	475	....	1, 3
Methane	Marsh gas	gas	....	5.3	13.9	999	No	....	0.554	-300	-258	4
Methoxyl ethy phthalate	Methox	275	370	....	....	....	No	....	....	....	....	1, 2, 3
Methyl acetate		15	20	4.1	13.9	935	No	0.925	2.56	-146	140	3
Methyl acetoacetate		180	....	....	....	....	No	1.077	4.00	82	338	1, 2, 3
Methyl alcohol	Methanol	54	60	6.0	36.5	878	No	0.792	1.11	-144	147	3
Methyl amine		0	10	....	....	....	No	0.699	....	-134	19	3
Methyl bromide	Bromomethane	practically non-flammable		13.5	14.5	....	No	1.732	3.27	-135	40	....
Methyl n-butyl ketone	Hexanone	....	95	1.22	8.0	....	No	0.830	3.45	-70	262	2, 3
Methyl iso-butyl ketone	Hexanone	73	....	....	....	....	No	0.803	3.45	-121	244	2, 3
Methyl butyrate		57	....	....	....	....	No	0.898	3.52	<-142	215	2, 3
Methyl carbitol		....	200	....	....	....	No	1.035	4.14	....	379	1, 3
Methyl cellosolve		107	115	....	....	551	No	0.966	2.62	....	255	3
Methyl cellosolve acetate		132	140	....	....	....	No	1.005	4.07	....	289	3
Methyl chloride	Chloromethane	gas	....	8.2	19.7	....	No	0.92	1.78	-142	-11	4
Methyl cyclohexane		25	....	1.15	....	....	No	0.770	3.38	-195	214	2, 3

See Table P 600.11 (sheet 1) for explanation of symbols.

Table by courtesy of Associated Factory Mutual Fire Insurance Companies.

For the big job in *New Building*

When you unfold the blueprints for new homes... new commercial buildings... new plants and reconversion... start the job *right* with TOLEDO Pipe Tools! These are the tools for best work by green hands or experienced mechanics—unbeatable for accurate, reliable, easy-threading operation for nearly half a century.

Toledo Engineering Leadership designed this ahead-of-the-times tool... the Toledo SIMPACT Threader! Entirely self-contained, adjustable for 1″ to 2″ pipe. Sizes changed instantly with one set high speed steel dies. Accurate, dependable. Specify TOLEDO for better pipe tools and better building! The Toledo Pipe Threading Machine Company, Toledo, Ohio. New York Office, No. 2 Rector Street Bldg.

RELY ON THE LEADER... **TOLEDO**

FOR PRECISION PIPE TOOLS

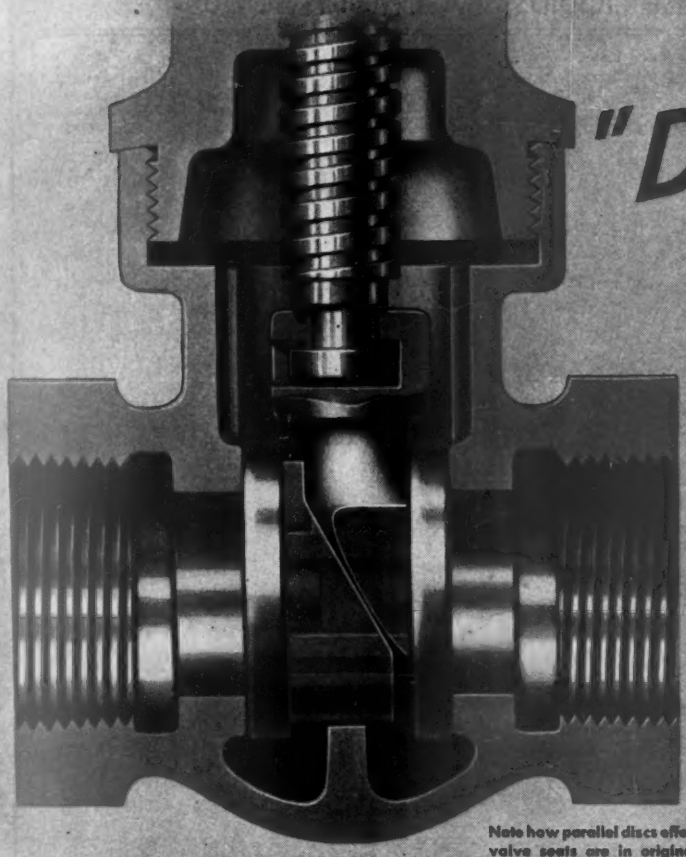
PROPERTIES OF FLAMMABLE LIQUIDS, GASES, AND SOLIDS

Name	Synonyms	Flash point, °F.		Explosive limits, per cent by vol. in air		Auto-ignition temp., °F.	Susceptibility to spontaneous heating	Specific gravity (water = 1.00)	Vapor density (air = 1.00)	Melting point, °F.	Boiling point, °F.	Suitable Extinguishing agents
		Closed cup	Open cup	Lower	Upper							
Methyl cyclohexanol	Methyl hexalin	154	....	....	....	....	No	0.933	3.93	....	329	1, 2, 3
Methyl cyclohexanone		118	....	....	....	....	No	0.925	4.86	....	325	2, 3
Methyl cyclohexyl acetate		147	....	....	....	....	No	....	5.37	....	....	2, 3
Methylene chloride	Dichloromethane	practically non-flammable		....	....	1224	No	1.336	2.93	−143	104	1, 2, 3
Methyl ethyl ether		−35	....	2	10.1	374	No	0.697	2.07	....	50	3
Methyl ethyl ketone		30	....	1.81	11.5	....	No	0.805	2.41	−123	176	3
Methyl formate		−2	....	5.0	22.7	840	No	0.975	2.07	−148	90	3
Methyl glycol		97	....	....	....	....	No	....	2.62	....	....	3
Methyl glycol acetate		111	....	....	....	....	No	....	4.07	....	....	3
Methyl phthallyl ethyl glycollate		375	380	....	....	....	No	>1	....	....	....	1, 2, 3
Methyl propionate		28	....	....	....	....	No	0.915	3.03	−126	176	2, 3
Methyl n-propyl ketone	Pentanone	....	60	1.55	8.15	....	No	0.812	2.96	−108	216	3
Methyl salicylate	Oil of wintergreen	214	225	....	....	850	No	1.182	5 24	18	432	1, 2, 3
Mineral seal oil (typical)		170	255	....	....	....	No	....	....	....	....	1, 2, 3
Monocresyl diphenyl phosphate		450	450	....	....	....	No	>1	....	....	....	1, 2, 3
Monofluorotrichloro-methane	F-11	non-flammable		....	....	....	No	....	....	....	76	....
Mustard oil		566	....	....	....	....	Yes	1.02	....	....	300	1, 2, 3
Naphtha, coal tar	Hi-flash naphtha	100-110	....	....	....	900-950	No	<1	....	<-50	300-400	2, 3
Naphtha, safety solvent	Stoddard solvent, mineral spirits	100-110	....	1.1	6.0	450-500	No	<1	....	<-50	300-400	2, 3
Naphtha, V. M. & P.	Benzine	20-45	....	1.2	6.0	450-500	No	<1	....	<-50	212-320	2, 3
Naphthalene		174	190	0.9	....	1053	No	1.145	4.42	176	424	1, 3
Naphthol, beta		307	340	....	....	....	No	1.22	4.97	252	547	1, 3
Naphthylamine-alpha		315	....	....	....	....	No	1.171	4.93	122	572	1, 3
Neatsfoot oil		470	....	....	....	828	Yes	0.92	....	84-106	....	1, 2, 3
Nicotine		....	....	0.75	4.0	471	..	1.009	5.61	<175	475	3
p-Nitroaniline	Paranitraniline	390	390	....	....	....	..	1.437	....	295	>545	1, 3
Nitrobenzene		190	....	....	....	924	..	1.2	4.25	412	42	1, 2, 3
p-Nitrochlorobenzene		261	....	....	....	....	..	1.52	5.43	181	468	1, 3
Nitroethane		82	106	....	....	....	..	1.052	2.58	−130	273	3
Nitroglycerin	Glyceryl trinitrate	Explodes	....	....	....	518	No	1.601	7.84	....	....	....
Nitromethane		....	112	....	....	....	..	1.139	2.11	−19	214	3
Nitronaphthalene-alpha		327	....	....	....	....	..	1.331	5.96	140	579	1, 3
1-Nitropropane		....	120	....	....	....	..	1.003	3.06	−164	268	3
2-Nitropropane		....	103	....	....	....	..	0.992	3.06	−135	248	3
p-Nitrotoluene		223	....	....	....	....	..	1.286	4.72	126	460	1, 3
m-Nitro p-toluidine		315	345	....	....	....	..	1.312	5.24	241	....	1, 3
Nonane-n		88	....	0.74	2.9	....	No	0.718	4.41	−60	302	3
Octane-n		56	....	0.84	3.2	450	No	0.706	3.86	−69	257	3
Octyl acetate-n		180	....	....	....	....	No	0.885	5.93	−37	410	1, 2, 3
Octyl alcohol-n		178	....	....	....	....	No	0.827	4.48	3	351	2, 3
Octyl aldehyde		125	....	....	....	....	No	0.821	4.41	....	350	2, 3
Oleic acid	Red oil	372	....	....	....	685	Yes	0.891	....	13	432	1, 2, 3
Oleo oil		....	....	....	....	....	Yes	0.915	....	2	464	1, 2, 3,
Olive oil		437	....	....	....	826	Yes	0.910	....	21	....	1, 2, 3
Ozokerite		236	315	....	....	....	No	0.95	....	136-230	....	1, 3
Palm oil		421	....	....	....	650	Yes	0.92	....	100	....	1, 2, 3
Paraffin wax		390	430	....	....	473	No	0.9	....	122	>700	1, 3
Paraformaldehyde		158	200	....	....	....	No	....	....	sub. 248	....	1, 3
Peanut oil		540	....	....	....	833	Yes	0.92	....	37	....	1, 2, 3
Pentane-n		<-40	....	1.4	8.0	588	No	0.631	2.48	-206	97	2, 3
Perilla oil		522	....	....	....	....	Yes	0.93	....	23	....	1, 2, 3
Petroleum, crude		20-90	....	....	....	....	No	<1	....	....	....	2, 3
Petroleum ether		-50	....	1.4	5.9	475	No	0.64	2.50	<-100	100-160	3
Phenanthrene		....	....	....	....	....	No	1.063	6.14	212	644	....
Phenol	Carboile acid	175	185	....	....	1319	No	1.07	3.24	108	358	1, 3
Phenyl cellosolve		....	250	....	....	....	No	1.109	....	....	473	3
p-Phenylene diamine		312	310	....	....	....	No	....	3.72	284	512	1, 3
Phenyl ethyl alcohol		216	....	....	....	....	No	1.024	4.21	....	430	1, 2, 3
Phosphorous (red)		....	....	....	....	500	No	2.30	....	1337	....	1
Phosphorous (yellow)		....	....	....	....	86	No	1.82	....	112	549	1
Phosphorous sesquisulfide		....	....	....	....	212	No	2.03	....	342	765	1
Phthalic anhydride		305	330	....	....	....	No	1.527	5.10	262	543	1, 3
Picric acid	Trinitrophenol	Explodes	....	....	....	<572	No	1.763	7.90	250	....	1
Pine oil		172	175	....	....	....	Yes	0.86	....	....	....	1, 2, 3
Pine pitch		285	....	....	....	....	Yes	....	....	148	490	1, 3
Pine resin	Colophony	370	430	....	....	....	Yes	1.08	....	212-300	....	1, 3
Pine tar		130	255	....	....	671	Yes	....	....	....	208	2, 3
Pine tar oil		144	....	....	....	....	Yes	0.862	....	....	....	3
Potassium*		....	....	....	....	....	No	0.862	....	144	1396	5
Potassium xanthate		205	....	....	9.5	....	No	1.558	....	d.>392	....	1, 3

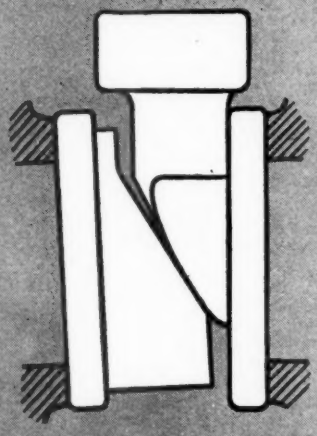
See Table P 600.11 (sheet 1) for explanation of symbols.

Table by courtesy of Associated Factory Mutual Fire Insurance Companies.

DARLING... the valve that can give you "DROP-TIGHT" SEATING ...



Note how parallel discs effect tight closure when valve seats are in original parallel position.



This greatly exaggerated diagram shows how the curved face of the upper wedge allows the discs to fit against seats, "unparalleled" by valve body distortion.

Darling manufactures a quality line of gate valves for long service—in parallel seat or tapered seat—slotted or solid wedge types—for service pressures up to 3000 pounds. Valves are available in cast iron, bronze, cast steel, forged steel, corrosion resisting and special alloys. Darling also manufactures check valves, compression type fire hydrants, motor and cylinder operated valves, and accessories.

THERE is one gate valve design that insures "drop-tight" seating, year after year. It is the unique Darling design. Darling's fully revolving double disc parallel seat gate valve provides:

1. ADAPTABILITY—Any valve can close tight the day before it is installed. But the day after is another story. Pipe out of alignment and bolting strains distort valve bodies. Pressure and temperature changes and other operating strains force valve bodies out of shape, too, so that gate and seats do not remain parallel.

To compensate for "unparalleled" seats, in the Darling valve wedging assembly a straight or tangent surface on the lower wedge acts on a curved or "radius" surface on the upper wedge. So no matter what position valve seats reach in years of usage, the Darling twin discs make perfect closures.

2. UNIFORM WEAR—The twin discs are free to revolve 360°, seating in a different position each time the valve is operated. Wear on discs and seats is uniform, making possible tight closing year after year.

3. INSTANT RELEASE—The four simple parts of the valve assembly—two discs, two wedges—release at the first fractional turn of the stem to open. The gate is immediately free to rise with little or no friction.

For over 40 years engineers have found that Darling Valves give "drop-tight" shut-off, long life and low maintenance.

NOW—when maximum uninterrupted production is all-important—you can safeguard it by installing Darling Valves. Later, when low-cost operation and maintenance are vital, you will be all set with valves that help you keep costs down and help you compete in postwar markets.

TRADE DARLING MARK

DARLING VALVE & MANUFACTURING CO.
WILLIAMSPORT, PA.

PROPERTIES OF FLAMMABLE LIQUIDS, GASES, AND SOLIDS

Name	Synonyms	Flash point, °F.		Explosive limits, per cent by vol. in air		Auto-ignition temp., °F.	Susceptibility to spontaneous heating	Specific gravity (water=1.00)	Vapor density (air=1.00)	Melting point, °F.	Boiling point, °F.	Suitable Extinguishing agents
		Closed cup	Open cup	Lower	Upper							
Propane		gas	....	2.37	9.5	871	No	....	1.56	-310	-45	4
Propyl acetate-n		58	....	2.0	....	....	No	0.886	3.52	-134	215	2, 3
Propyl acetate-iso		43	45	2.0	....	860	No	0.877	3.52	-99	194	2, 3
Propyl alcohol-n		59	85	2.5	....	812	No	0.804	2.07	-197	207	3
Propyl alcohol-iso		53	60	2.5	....	852	No	0.789	2.07	-122	181	3
Propyl alcohol-sec	Dimethyl carbinol	67	....	....	....	....	No	0.79	2.07	-186	116	3
Propyl benzene-n		86	....	....	....	....	No	0.862	4.14	-152	316	2, 3
Propyl benzene-iso	Cumene	102	....	....	....	....	No	0.864	4.14	-152	311	2, 3
Propyl chloride-n	1-Chloropropane	....	....	2.6	10.5	....	..	0.890	2.71	-188	115	3
Propylene		gas	....	2.0	11.1	....	No	....	1.49	-301	-58	4
Propylene chlorohydrin		125	125	....	....	....	No	1.113	3.26	....	261	3
Propylene dichloride	Dichloropropane-1, 2	59	65	3.4	14.5	1035	No	1.15	3.89	<-112	205	2, 3
Propylene glycol		210	225	....	....	....	No	1.040	2.52	....	370	1, 3
Propylene oxide		<20	....	....	....	....	No	0.859	2.00	....	95	3
Propyl ether-iso		-18	-15	....	....	830	No	0.73	3.52	<-76	156	2, 3
Propyl formate-n		27	....	....	....	....	No	0.909	3.03	-135	178	2, 3
Propyl formate-iso		22	....	....	....	....	No	0.873	3.03	....	153	2, 3
Pyridine		68	....	1.8	12.4	1065	No	0.982	2.73	-44	239	3
Pyrocatechol	o-Dihydroxy benzene	261	....	....	....	....	No	1.344	3.79	221	474	1, 3
Quenching oil		365	405	....	....	....	No	0.9	....	....	....	1, 2, 3
Rape seed oil		325	550	....	....	836	Yes	0.915	....	63	....	1, 2, 3
Resorcinol	m-Dihydroxy benzene	261	....	....	....	....	No	1.272	3.79	230	529	1, 3
Rosin oil		266	....	....	....	648	Yes	0.98-1.1	....	....	....	1, 2, 3
Sodium*		....	....	....	....	....	No	0.97	....	208	1612	5
Sodium formate		....	....	....	....	....	No	1.919	....	....	520	1
Soya bean oil		540	....	....	....	833	Yes	0.925	....	72	....	1, 2, 3
Stearic acid		385	425	....	....	743	Yes	0.847	9.80	157	726	1, 3
Styrene		90	....	1.1	6.1	914	..	0.907	3.60	-24	295	2, 3
Sulphur		405	440	....	....	450	No	2.046	....	234	832	1
Sulphur chloride		245	None	....	....	453	No	1.687	3.31	-112	280	1, 3
Tallow		509	....	....	....	....	Yes	0.895	....	88-100	....	1, 3
Tallow oil		492	....	....	....	....	Yes	0.914	....	109	....	1, 3
Tannic acid		....	390	....	....	....	No	....	....	d. 392	....	1
Tartaric acid	Racemic acid	....	410	....	....	....	No	1.667	....	284	....	1
Terphenyl-o		....	325	....	....	....	..	1.14	7.95	....	630	1, 3
Terphenyl-m		....	375	....	....	....	..	1.164	7.95	....	685	1, 3
Terphenyl-p		....	405	....	....	....	..	1.236	7.95	....	759	1, 3
Tetrachloroethylene	Perchlorethylene	non-flammable		....	....	....	No	1.623	5.72	-8	248	....
Tetradecane		212	....	0.5	....	....	No	0.765	6.83	41	486	1, 2, 3
Tetraethylene glycol		....	345	....	....	....	No	1.126	....	....	621	1, 3
Tetrahydronaphthalene	Tetralin	171	180	....	....	....	No	0.973	4.55	-24	403	1, 2, 3
Tin tetramethyl		....	....	1.9	....	....	No	1.314	....	....	172	2, 3
Toluene	Toluol	40	45	1.27	7.0	1026	No	0.866	3.14	-134	232	2, 3
o-Toluidine	2-Methyl aniline	185	....	....	....	900	No	0.999	3.90	3	392	1, 2, 3
p-Toluidine	4-Methyl aniline	188	205	....	....	900	No	0.973	3.90	111	392	1, 3
o-Tolyl p-toluene sulfonate		363	....	....	....	....	..	....	....	....	....	1, 3
Transil oil	Transformer oil	....	295	....	....	....	No	0.9	....	....	....	1, 2, 3
Tributyl citrate		315	365	....	....	695	..	....	....	-4	450	1, 3
Tributyl phosphate		....	295	....	....	....	No	0.973	8.86	<-112	560	1, 2, 3
Trichloroethylene		non-flammable		....	....	....	No	1.47	4.53	-99	189	....
o-Tricresyl phosphate		460	504	....	....	....	No	....	....	....	d. 770	1, 2, 3
Triethanolamine		355	365	....	....	....	No	1.13	5.14	68	650	1, 3
Triethylene glycol	Dicaproate	350	385	....	....	....	No	1.125	5.17	23	550	1, 3
Triethylene tetramine		....	260	....	....	....	No	0.982	....	....	532	1, 3
Triglycol dichloride		....	250	....	....	....	No	1.197	....	....	466	1, 3
Triisopropanolamine		....	305	....	....	....	No	1.020	....	....	570	1, 3
Triphenyl phosphate		428	....	....	....	....	No	....	....	122	750	1, 3
Tung oil	China wood oil	552	....	....	....	855	Yes	0.94	....	88	....	1, 3
Turkey red oil		476	....	....	....	833	No	....	....	....	....	1, 2, 3
Turpentine		95	....	0.8	....	488	Yes	<1	....	....	300	2, 3
Vinyl acetate		18	30	....	....	800	No	....	....	....	....	2, 3
Vinyl chloride		....	....	4	22	....	No	0.97	2.15	-256	57	3
Vinyl ether	Divinyl ether	<-22	....	1.85	36.5	680	..	0.774	2.41	....	102	3
Whale oil	Sperm oil	446	....	....	....	....	Yes	0.925	....	32	....	1, 2, 3
o-Xylene	o-Xylol	63	75	1.0	....	924	No	0.88	3.66	-17	291	2, 3
o-Xylidine	o-Dimethyl aniline	206	....	....	....	....	No	0.99	4.17	<5	435	1, 2, 3
Zinc (dust or powder)*		....	....	....	....	....	No	....	....	787	1706	5
Zirconium (powder)		....	....	....	....	550	No	....	....	3092	>5350	5

See Table P 600.11 (sheet 1) for explanation of symbols.

Table by courtesy of Associated Factory Mutual Fire Insurance Companies.

This is Why the Nash is the Most Simple Compressor

It's the Nash!

There are no mechanical complications in a Nash Compressor. A single moving element, a round rotor, with shrouded blades, forming a series of buckets, revolves freely in an elliptical casing containing any low viscosity liquid. This liquid, carried with the rotor, follows the elliptical contour of the casing.

The moving liquid therefore recedes from the rotor buckets at the wide part of the ellipse, permitting the buckets to fill with gas from the stationary Inlet Ports. As the casing narrows, the liquid is forced back into the rotor buckets, compressing the gas, and delivering it through the fixed Outlet Ports.

Nash Compressors produce 75 lbs. pressure in a single stage, with capacities to 6 million cu. ft. per day in a single structure. Since compression is secured by an entirely different principle, gas pumping problems difficult with ordinary pumps are often handled easily in a Nash.

Nash simplicity means low maintenance cost, with original pump performance constant over long periods. Data on these pumps sent immediately on request.

No internal wearing parts.

No valves, pistons, or vanes.

No internal lubrication.

Low maintenance cost.

Saves floor space.

Desired delivery temperature automatically maintained.

Slugs of liquid entering pump will do no harm.

75 pounds in a single stage.

NASH ENGINEERING COMPANY

323 WILSON, SO. NORWALK, CONN.

PRESSURE EXTENSIONS—ORIFICE METER CALCULATIONS

Static Press. 2800-2895-lb.

Differential pressure, in. of water	Static pressure, lb. per sq. in., ga.																			
	2800	2805	2810	2815	2820	2825	2830	2835	2840	2845	2850	2855	2860	2865	2870	2875	2880	2885	2890	2895
2	75.03	75.08	75.15	75.22	75.30	75.35	75.42	75.49	75.55	75.62	75.69	75.75	75.82	75.89	75.95	76.02	76.09	76.14	76.21	76.29
4	106.1	106.2	106.3	106.4	106.5	106.6	106.7	106.8	106.9	106.9	107.1	107.1	107.2	107.3	107.4	107.5	107.6	107.7	107.8	107.9
6	130.0	130.1	130.2	130.3	130.5	130.6	130.7	130.8	130.9	131.0	131.1	131.2	131.4	131.5	131.6	131.7	131.8	131.9	132.1	132.2
8	150.1	150.2	150.4	150.5	150.6	150.8	150.9	151.0	151.1	151.3	151.4	151.5	151.7	151.8	151.9	152.1	152.2	153.2	152.5	152.6
10	167.8	167.9	168.1	168.2	168.4	168.5	168.7	168.8	168.9	169.1	169.3	169.4	169.5	169.7	169.8	169.9	170.1	170.3	170.4	170.6
12	183.8	183.9	184.1	184.3	184.5	184.6	184.8	184.9	198.1	185.2	185.4	185.6	185.7	185.9	186.0	186.2	186.4	186.5	186.7	186.9
14	198.5	198.7	198.9	199.1	199.3	199.4	199.6	199.8	199.9	200.1	200.3	200.5	200.6	200.8	200.9	201.2	201.4	201.5	201.7	201.9
16	212.2	212.4	212.6	212.8	213.0	213.2	213.4	213.6	213.7	213.9	214.1	214.3	214.5	214.7	214.8	215.0	215.2	215.4	215.6	215.8
18	225.1	225.3	225.5	225.7	225.9	226.1	226.3	226.5	226.7	226.9	227.1	227.3	227.5	227.7	227.9	228.1	228.3	228.5	228.7	228.9
20	237.3	237.5	237.7	237.9	238.1	238.3	238.5	238.8	238.9	239.2	239.4	239.6	239.8	240.0	240.2	240.4	240.6	240.8	241.0	241.3
21	243.2	243.4	243.6	243.8	244.0	244.2	244.5	244.7	244.9	245.1	245.3	245.5	245.7	245.9	246.1	246.4	246.6	246.8	247.0	247.2
22	248.8	249.0	249.3	249.5	249.7	249.9	250.2	250.4	250.6	250.8	251.1	251.2	251.5	251.7	251.9	252.1	252.4	252.6	252.8	253.0
23	254.5	254.7	254.9	255.1	255.4	255.6	255.8	256.1	256.2	256.5	256.7	256.9	257.2	257.4	257.6	257.8	258.1	258.3	258.5	258.7
24	259.9	260.1	260.4	260.6	260.9	261.1	261.3	261.6	261.7	262.0	262.2	262.4	262.7	262.9	263.1	263.4	263.6	263.8	264.1	264.3
25	265.3	265.5	265.7	266.0	266.2	266.4	266.7	266.9	267.1	267.4	267.6	267.8	268.1	268.3	268.5	268.8	269.0	269.2	269.5	269.7
26	270.5	270.8	271.0	271.3	271.5	271.7	271.9	272.2	272.4	272.7	272.9	273.1	273.4	273.7	273.9	274.1	274.4	274.6	274.8	275.1
27	275.7	275.9	276.2	276.4	276.7	276.9	277.1	277.4	277.6	277.9	278.1	278.3	278.6	278.9	279.1	279.3	279.6	279.8	280.1	280.3
28	280.8	281.0	281.3	281.5	281.8	282.0	282.3	282.5	282.7	283.0	283.3	283.5	283.8	284.0	284.2	284.5	284.8	284.9	285.2	285.5
29	285.7	285.9	286.2	286.5	286.7	286.9	287.2	287.5	287.7	287.9	288.3	288.5	288.7	289.0	289.2	289.5	289.8	289.9	290.2	290.5
30	290.6	290.8	291.1	291.4	291.6	291.9	292.1	292.4	292.6	292.9	293.2	293.4	293.7	293.9	294.2	294.4	294.7	294.9	295.2	295.5
31	295.4	295.7	295.9	296.2	296.5	296.7	297.0	297.3	297.5	297.8	298.1	298.3	298.6	298.8	299.1	299.3	299.6	299.8	300.1	300.4
32	300.2	300.4	300.7	300.9	301.2	301.5	301.7	302.0	302.2	302.5	302.8	303.0	303.3	303.6	303.8	304.1	304.4	304.6	304.9	305.2
33	304.8	305.1	305.3	305.6	305.9	306.1	306.4	306.7	306.9	307.2	307.5	307.8	308.0	308.3	308.6	308.8	309.1	309.4	309.7	309.9
34	309.4	309.6	309.9	310.2	310.5	310.7	311.0	311.3	311.5	311.8	312.1	312.4	312.7	312.9	313.2	313.5	313.8	314.0	314.3	314.6
35	313.9	314.1	314.4	314.7	315.0	315.3	315.6	315.9	316.1	316.4	316.7	316.9	317.2	317.5	317.7	318.0	318.3	318.6	318.9	319.2
36	318.4	318.6	318.9	319.2	319.5	319.7	320.0	320.3	320.6	320.9	321.2	321.4	321.7	322.0	322.3	322.6	322.9	323.1	323.4	323.7
37	322.8	323.0	323.3	323.6	323.9	324.2	324.5	324.8	325.0	325.3	325.6	325.9	326.2	326.5	327.7	327.0	327.3	327.6	327.9	328.2
38	327.1	327.3	327.6	327.9	328.2	328.6	328.8	329.1	329.3	329.6	329.9	330.2	330.5	330.8	331.1	331.4	331.7	331.9	332.2	332.5
39	331.4	331.6	331.9	332.2	332.5	332.8	333.1	333.4	333.7	333.9	334.3	334.5	334.9	335.2	335.4	335.7	336.0	336.3	336.6	336.9
40	335.6	335.9	336.2	336.5	336.8	337.1	337.4	337.7	337.9	338.3	338.6	338.8	339.1	339.5	339.7	340.0	340.3	340.6	340.9	341.2
41	339.7	340.0	340.3	340.6	340.9	341.2	341.5	341.9	342.1	342.4	342.7	343.0	343.3	343.6	343.9	344.2	344.5	344.8	345.1	345.4
42	343.9	344.1	344.5	344.8	345.1	345.4	345.7	346.0	346.3	346.6	346.9	347.2	347.5	347.8	348.1	348.4	348.7	349.0	349.3	349.6
43	347.9	348.2	348.5	348.8	349.2	349.4	349.7	350.1	350.3	350.7	351.0	351.3	351.6	351.9	352.2	352.5	352.8	353.1	353.4	353.7
44	351.9	352.2	352.5	352.9	353.2	353.5	353.8	354.1	354.4	354.7	355.1	355.3	355.7	355.9	356.3	356.6	356.9	356.2	357.5	357.8
45	355.9	356.2	356.5	436.9	357.2	357.5	357.8	358.1	358.4	358.7	359.1	359.3	359.7	360.0	360.3	360.6	360.9	361.2	361.6	361.9
46	359.8	360.1	360.5	360.8	361.1	361.4	361.7	362.1	362.4	362.7	363.0	363.3	363.6	363.9	364.3	364.6	364.9	365.2	365.5	365.9
47	363.8	364.1	364.4	364.8	365.1	365.4	365.7	366.1	366.4	366.7	367.1	367.3	367.7	368.0	368.3	368.6	368.9	369.2	369.6	369.9
48	367.6	367.9	368.2	368.6	368.9	369.2	369.5	369.9	370.2	370.5	370.9	371.1	371.5	371.8	372.1	372.4	372.8	373.1	373.4	373.8
49	371.4	371.7	372.0	372.4	372.7	373.0	373.4	373.7	374.0	374.4	374.7	374.9	375.3	375.7	375.9	376.3	376.7	376.9	377.3	377.6
50	375.2	375.5	375.8	376.2	376.5	376.8	377.2	377.5	377.8	378.2	378.5	378.8	379.1	379.5	379.8	380.1	380.5	380.8	381.1	381.5
51	378.9	379.2	379.5	379.9	380.3	380.5	380.9	381.3	381.5	381.9	382.3	282.5	382.9	383.3	383.5	383.9	384.3	384.5	384.9	385.3
52	382.6	382.9	383.3	383.6	383.9	384.3	384.6	385.0	385.3	385.6	386.0	386.3	386.6	387.0	387.3	387.7	388.0	388.3	388.7	389.0
53	386.3	386.6	386.9	387.3	387.7	387.9	388.3	388.7	388.9	389.3	389.7	389.9	390.3	390.7	391.0	391.4	391.7	392.0	392.4	392.8
54	389.9	390.2	390.5	390.9	391.3	391.6	391.9	392.3	392.6	393.9	393.3	393.6	394.0	394.4	394.7	395.0	395.4	395.7	396.1	396.1
55	393.5	393.8	394.2	394.5	394.9	395.2	395.6	395.9	396.2	396.6	396.9	397.2	397.6	398.0	398.3	398.7	399.0	399.3	399.7	400.1
56	397.0	397.3	397.7	398.1	398.5	398.8	399.1	399.5	399.8	4002.	400.6	400.9	401.2	401.6	401.9	402.3	402.7	402.9	403.3	403.7
57	400.6	400.9	401.3	401.7	402.0	402.3	402.7	403.1	403.4	403.8	404.1	404.4	404.8	405.2	405.5	405.9	406.3	406.6	406.9	407.3
58	404.1	404.4	404.8	405.2	405.5	405.9	406.2	406.6	406.9	407.3	407.7	407.9	408.4	408.7	409.1	409.4	409.8	410.1	410.5	410.9
59	407.5	407.9	408.2	408.6	409.0	409.3	409.7	410.1	410.4	410.8	411.1	411.5	411.9	412.2	412.5	412.9	413.3	413.6	414.0	414.4
60	411.0	411.3	411.7	412.1	412.5	412.8	413.2	413.6	413.9	414.3	414.6	414.9	415.3	415.7	416.0	416.4	416.8	417.1	417.5	417.9
61	414.4	414.7	415.1	415.5	415.9	416.2	416.6	416.9	417.3	417.7	418.1	418.4	418.8	419.2	419.5	419.9	420.3	420.6	420.9	421.3
62	417.8	418.1	418.5	418.9	419.3	419.6	420.0	420.4	420.7	421.1	421.5	421.8	422.2	422.6	422.9	423.3	423.7	424.0	424.4	424.8
63	421.1	421.4	421.8	422.2	422.6	422.9	423.4	423.8	424.1	425.4	424.9	425.2	425.6	425.9	426.3	426.7	427.1	427.4	427.8	428.2
64	424.5	424.8	425.2	425.6	426.0	426.3	426.7	427.1	427.4	427.8	428.2	428.6	428.9	429.4	429.7	430.1	430.5	430.8	431.2	431.6
65	427.8	428.1	428.5	428.9	429.3	429.6	430.0	430.4	430.7	431.2	431.6	431.9	432.3	432.7	433.0	433.4	433.8	434.1	434.5	434.9
66	431.1	431.4	431.8	432.2	432.6	432.9	433.3	433.7	434.1	434.5	434.9	435.2	435.6	436.0	436.3	436.7	437.1	437.5	437.9	438.3
67	434.3	434.6	435.0	435.4	435.8	436.2	436.6	437.0	437.3	437.7	438.1	438.5	438.9	439.3	439.6	440.0	440.4	440.8	441.2	441.6
68	437.5	437.9	438.3	438.7	439.1	439.4	439.8	440.2	440.6	441.0	441.4	441.7	442.1	442.6	442.9	443.3	443.7	444.0	444.5	444.9
69	440.8	441.1	441.5	441.9	442.3	442.7	443.1	443.5	443.8	444.3	444.7	445.0	445.4	445.8	446.2	446.6	447.0	447.3	447.7	448.2
70	443.9	444.3	444.7	445.1	445.5	445.9	446.3	446.7	447.0	447.5	447.9	448.2	448.6	449.1	449.4	449.8	450.2	450.6	450.9	451.4
71	447.1	447.4	447.8	448.3	448.7	449.0	449.4	449.9	450.2	450.6	451.0	451.4	451.8	452.2	452.6	452.9	453.4	453.7	454.2	454.6
72	450.2	450.5	450.9	451.4	451.8	452.2	452.6	453.0	453.3	453.8	454.2	454.5	454.9	455.4	455.7	456.1	456.6	456.9	457.3	457.8
73	453.3	453.7	454.1	454.5	454.9	455.3	455.7	456.2	456.5	456.9	457.4	457.7	458.1	458.6	458.9	459.3	459.7	460.1	460.5	460.9
74	456.4	456.8	457.2	457.6	458.1	458.4	458.8	459.3	459.6	460.0	460.5	460.8	461.2	461.7	462.0	462.4	462.9	463.2	463.6	464.1
75	459.5	459.8	460.3	460.7	461.1	461.5	461.9	462.4	462.7	463.1	463.6	463.9	464.3	464.8	465.1	465.6	465.9	466.3	466.8	467.2
76	462.6	462.9	463.4	463.8	464.2	464.6	465.0	465.4	465.8	466.2	466.7	467.0	467.5	467.9	468.2	468.7	469.1	469.5	469.8	470.3
77	465.6	465.9	466.4	466.8	467.3	467.6	468.1	468.5	468.8	469.3	469.7	470.1	470.5	470.9	471.3	471.7	472.2	472.5	472.9	473.4
78	468.6	468.9	469.4	469.9	470.3	470.7	471.1	471.5	471.9	472.3	472.8	473.1	473.6	474.0	474.4	474.8	475.2	475.6	476.0	476.5
79	471.6	471.9	472.4	472.8	473.3	473.6	474.1	474.5	474.9	475.3	475.8	476.1	476.6	477.0	477.4	477.8	478.3	478.6	479.1	479.5
80	474.6	474.9	475.4	475.8	476.3	476.6	477.1	477.5	477.9	478.3	478.8	479.1	479.6	480.0	480.4	480.8	481.3	481.6	482.1	482.5
81	477.5	477.9	478.3	478.8	479.2	479.6	480.1	480.5	480.9	481.3	481.8	482.1	482.6	483.0	483.4	483.8	484.3	484.6	485.1	485.5
82	480.5	480.8	481.3	481.7	482.2	482.5	482.9	483.4	483.8	484.3	484.7	485.1	485.5	485.9	486.3	486.8	487.2	487.6	488.1	488.5
83	483.4	483.7	484.2	484.6	485.1	485.5	485.9	486.4	486.7	487.2	487.7	488.0	488.5	488.9	489.3	489.7	490.2	490.6	491.0	491.5
84	486.3	486.7	487.1	487.6	488.0	488.4	488.9	489.3	489.7	490.1	490.6	490.9	491.4	491.9	492.2	492.7	493.2	493.5	493.9	494.4
85	489.2	489.6	490.0	490.5	490.9	491.3	491.8	492.3	492.6	493.1	493.5	493.9	494.4	494.9	495.2	495.7	496.1	496.5	496.9	497.4
86	492.1	492.4	492.9	493.4	493.8	494.2	494.7	495.1	495.5	495.9	496.4	496.8	497.3	497.7	498.1	498.6	499.0	499.4	499.9	500.3
87	494.9	495.3	495.7	496.2	496.7	497.0	497.5	497.9	498.3	498.8	499.3	499.6	500.1	500.6	500.9	501.4	501.9	502.3	502.7	503.2
88	497.8	498.1	498.6	499.1	499.5	499.9	500.4	500.8	501.2	501.7	502.2	502.5	503.0	503.5	503.8	504.3	504.8	505.2	505.6	506.1
89	500.6	500.9	501.4	501.9	502.4	502.7	503.2	503.7	504.1	504.5	505.0	505.4	505.8	506.3	506.7	507.2	507.6	508.0	508.5	508.9
90	503.4	503.8	504.2	504.7	505.2	505.6	506.0	506.5	506.9	507.4	507.8	508.2	508.7	509.2	509.5	410.0	510.5	510.9	511.3	511.8
91	506.1	506.5	507.0	507.5	507.9	508.3	508.8	509.3	509.7	510.1	510.6	511.0	511.5	511.9	512.3	512.8	513.3	513.7	514.1	514.6
92	508.9	509.3	509.8	510.3	510.8	511.2	511.6	512.1	512.5	512.9	513.5	513.8	514.3	514.8	515.2	515.7	516.1	516.5	517.0	517.5
93	511.7	512.1	512.6	513.1	513.5	513.9	514.4	514.9	515.3	515.8	516.2	516.6	517.1	517.6	517.9	518.5	518.9	519.3	519.8	520.3
94	514.4	514.8	515.3	515.8	516.3	516.6	517.1	517.6	518.0	518.5	518.9	519.4	519.8	520.3	520.7	521.2	521.7	522.1	522.6	523.0
95	517.2	517.6	518.0	518.5	519.0	519.4	519.9	520.4	520.8	521.3	521.8	522.1	522.6	523.1	523.5	524.0	524.5	524.9	525.4	525.8
96	519.9	520.3	520.8	521.2	531.7	522.1	522.6	523.1	523.5	524.0	524.5	524.9	525.4	525.9	526.2	526.7	527.2	527.6	528.1	528.6
97	522.6	522.9	523.5	523.9	524.5	524.8	525.3	525.8	526.2	526.7	527.2	527.6	528.1	528.6	528.9	529.5	529.9	530.4	530.9	531.3
98	525.2	525.6	526.1	526.6	527.1	527.5	528.0	528.5	528.9	529.4	529.9	530.3	530.8	531.3	531.7	532.2	532.7	533.1	533.5	534.0
99	527.9	528.3	528.8	529.3	529.8	530.2	530.7	431.2	531.6	532.1	532.6	533.0	533.5	534.0	534.4	534.9	535.4	535.8	526.3	536.8
100	530.6	531.0	531.5	532.0	532.5	532.9	533.4	533.9	534.3	534.8	535.3	535.7	536.2	536.7	537.1	537.6	538.1	538.5	539.0	539.5

NOTE: Values given in body of table are products of the square roots of the static and differential pressures in lb. per sq. in., abs., and inches of water, respectively.
Absolute pressures are based on atmospheric pressure of 15 lb. per sq. in.
Table has been condensed to serve field men in approximating meter readings. Intermediate readings for accurate measurements may be obtained from pressure extension books, usually available in district offices.

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Running Tour WITH MEN IN THE INDUSTRY

● **Dr. Joseph A. Sharpe** has resigned as chief physicist of the Stanolind Oil and Gas Company to become associated with C. H. Frost Gravimetric Surveys, Inc., as vice president. With this organization, which manufactures gravimeters and conducts contract gravimetric field surveys, he will be primarily concerned with the geophysical and geologic interpretation of gravimetric surveys. After his graduation from the University of Arizona in 1928, Dr. Sharpe was instructor for 2 years at the university. He received his Ph.D. from the University of Wisconsin in 1934 at which place he had installed and operated the Madison seismological station. His new headquarters will be in the office, laboratory, and shop building occupied by C. H. Frost Gravimetric Surveys, Inc., 1242 South Boston Avenue, Tulsa, Oklahoma.

Dr. Joseph A. Sharpe

● **C. Walter Spalding,** manager of the power transmission machinery of Link-Belt Company, died on May 25 in Chicago. A veteran of World War I, Spalding maintained headquarters at the company's Ewart plant, Indianapolis, Indiana. He had been with Link-Belt since 1910.

● **Dr. G. P. Vincent** has been appointed from the position of manager of the sales development and technical service department of The Mathieson Alkali Works to that of the newly created position of technical director. In addition to his former duties, he will direct research and technical development and advise on technical matters concerning plant operation. In the latter capacities he replaces **R. E. Gage,** for 14 years director of research and development for Mathieson, promoted to technical adviser for the company. Dr. Vincent has been with the company since 1930 and Gage began his employ in 1916.

● **Harry D. Wagner** has joined the staff of engineers serving the Cleveland, Ohio, area, for The Foxboro Company. He has already taken up his new duties with headquarters at the company's office, 417 Bulkley Building, 1501 Euclid Avenue, Cleveland. Wagner has had extensive training in industrial instrumentation, having supervised the installation and operation of instruments in numerous plants, especially in the glass and rubber industries.

● **Allen B. Gibson** has been appointed director of production in the Southwest, District 3 PAW, with headquarters in Houston, Texas, according to Ralph K. Davies. Gibson has served as assistant director of production for the Southwest District since late in 1944. He succeeds **E. A. Wahlstrom,** who has resigned to return to private industry.

● **Rowland G. Whealton** of Los Angeles, California, has been appointed to the post of director of production for District 5, PAW, the Pacific Coast States. He has been with PAW since September, 1942, and replace **E. L. Davis,** who has resigned to return to private industry.

● **A. H. DeFriest,** for several years vice president and director of marketing has been promoted to assistant to the president of Socony-Vacuum Oil Company with headquarters at 26 Broadway, New York City. **C. S. Beesemyer,** a director of General Petroleum Corporation and former president of the Gilmore Oil Company has been appointed vice president and director of marketing succeeding DeFriest. **John C. Sample** will fill the position of general manager of the marketing department of General Petroleum.

● **Leslie A. Baldwin,** Greenwich, New York, vice president of Johns-Manville Sales Corporation, was honored by his business associates recently at a luncheon marking completion of his twenty-fifth year with the company. Baldwin has held a number of sales and executive positions with the company, specializing in selling, engineering, and construction work. His first position was as salesman in Kansas City, Missouri.

● **Alvin F. Franz** has been appointed general superintendent of the Buffalo plant of Wickwire Spencer Steel Company, according to R. T. Dunlap, vice president in charge of operations. Franz was previously general superintendent of the Allan Wood Steel Company, Philadelphia, Pennsylvania, a position that he held for 15 years. In his new position he will be in charge of all production at Buffalo, including Wickwire Spencer's open hearth, hot mill, and wire departments.

● **John W. Brice,** *executive vice president and director of The Carter Oil Company, affiliate of Standard Oil Company (N. J.), has assumed the post of assistant coordinator of Jersey's worldwide producing activities. Brice joined the Carter staff in April, 1942, as a director and vice president in charge of exploration activities. He will have his headquarters in the New York office of Standard of New Jersey.*

● **Elliott G. Ewell** has been appointed vice president and manager of Mack's southern division, according to A. C. Fetzer, vice president of Mack-International Motor Truck Corporation. Ewell has been with the firm since 1924 and will make his headquarters at 730 Peachtree Street, Atlanta, Georgia. He will be succeeded in Charlotte, North Carolina, as manager of that branch office by **L. D. Marshburn.**

● **W. K. Holmes,** superintendent of the Tulsa, Oklahoma, refinery of The Texas Company, died on June 4. He joined The Texas Company in 1907, and in 1926 was made superintendent of the Port Arthur, Texas, refinery. In 1931 he was elected vice president of the California Texas Company, with headquarters in Los Angeles, California.

● **Charles W. Olesen,** equipment engineer for the Stanolind Oil and Gas Company, Tulsa, Oklahoma, died of heart attack on June 3. He was a graduate of the Massachusetts Institute of Technology.

● **Colonel Walter C. Pew** has been awarded the Legion of Merit for "pioneer work in large scale personnel administration" according to the War Department. During the period of the Normandy invasion, Colonel Pew was deputy chief of petroleum, oil, and lubricants on General Dwight D. Eisenhower's staff. Previous to volunteering for duty with the army in 1942, Colonel Pew was general sales manager and director of Sun Oil Company. He was made a colonel in March, 1944, and headed a group of 54 picked oil men who sailed for Europe to speed invasion planning. After the Germans were driven from Paris, Colonel Pew became American head of the petroleum section of the SHAEF Mission to France that handles all the Allied armies' contacts with the French people and their government.

Colonel Walter C. Pew

● **Alexander C. Nagle,** New York City, has been elected a director and member of the finance committee of the United States Steel Corporation, succeeding the late Leon Fraser, according to Irving S. Olds, chairman of the corporation's board of directors. Nagle, who last month succeeded Fraser as president of the First National Bank of New York, has spent his entire business career with the bank. He was first employed in 1907. He is a director and member of the finance committee of the American Radiator and Standard Sanitary Corporation and a director and member of the executive committee of the National Biscuit Company, Federal Insurance Company, and Vigilant Insurance Company. He is also a trustee of the George F. Baker charity trust and president of the White Plains Hospital.

● **Louis E. Whyte** of Washington, D. C. has been appointed supervisor of the educational department of the Independent Natural Gas Association, according to John A. Ferguson, executive director. Whyte, with 15 years' experience in Washington with newspapers, trade journals, and business information service organizations, left the staff of the Bureau of National Affairs, affiliate of the United States News Organization, to accept the INGAA position. His work will include the handling of news releases, collection and dissemination of material of interest to association members and the conducting of a program designed to educate the public generally regarding the problems of the industry.

● **J. B. Ellzey** has been promoted from store manager of Bethlehem Supply Company's Houma, Louisiana, store to district manager of the company's newly created Louisiana Gulf District. He will have his office at the New Iberia store of the organization and will direct the company's activities in the territory assigned to the Houma, New Iberia, and Lake Charles stores. **T. H. Salter,** formerly district manager for the entire area, will now be manager for southeast Louisiana-Mississippi districts and will retain his office at the Harvey headquarters of the company.

● **Arch H. Rowan** spoke to the Petroleum Engineers' Club of Fort Worth, Texas, recently on his visit to Venezuela.

● **Ing. Amado Chapa** has been appointed to represent the Edward L. Carter organization in the Republic of Mexico. After schooling in Mexico and San Antonio, Texas, Chapa was graduated from the Colorado School of Mines with a degree in mining engineering. He has held positions with various companies in Mexico previous to his present export-import organization to promote trade between the United States and Mexico.

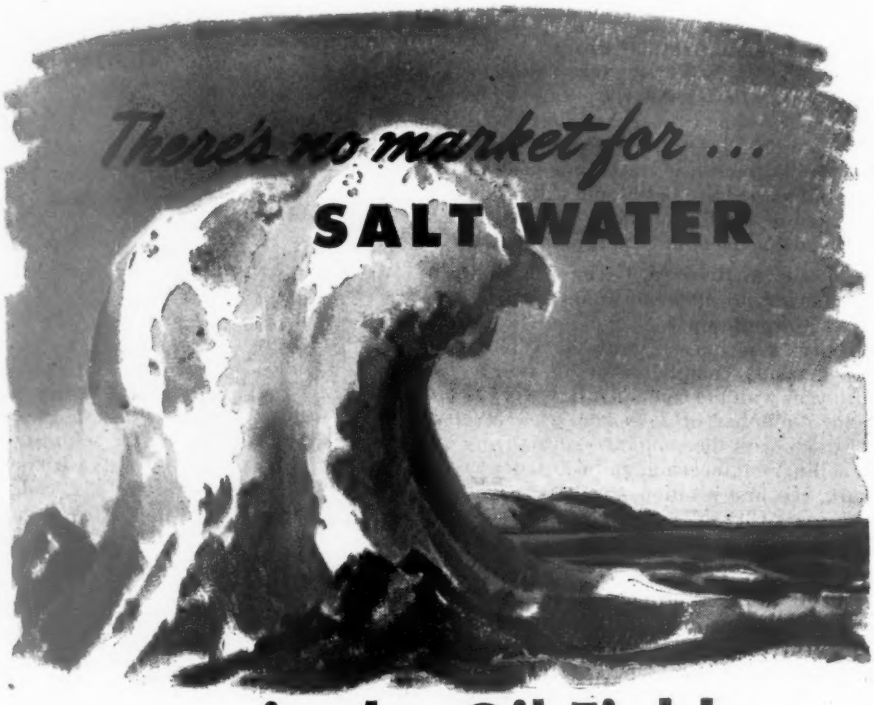
Ing. Amado Chapa

● **Charles W. Miller, Jr.,** has been appointed a member of the engineering staff of the Briggs Clarifier Company, manufacturers of modern oil filtration equipment, Washington, D. C., and Bethesda, Maryland. Miller has been actively associated with the aviation industry for more than 20 years. Previous to going with Briggs, Miller served as president of Aircraft Enterprises, Inc., Bridgeport, Connecticut.

● **H. O. Harder,** division superintendent, Cities Service Oil Company, Oklahoma City, was guest speaker recently at the annual banquet of the Petroleum Engineer's Club, University of Oklahoma. He talked on the economy, technique, and adaptability of cleaning out and reconditioning oil and gas wells by the new process of detonating glass marbles.

Lloyd B. Smith, *son of the late L. R. Smith, for many years chairman of the board of the A. O. Smith Corporation, was elected vice president and a member of the board at a director's meeting recently.* **Morris J. Vollmer,** *former assistant to the president, was named assistant secretary and assistant treasurer, and* **A. von Wening,** *vice president and controller, was elected to the board.*

● **Dr. Maxwell Gensamer,** a staff member at Carnegie Institute of Technology for 16 years, became professor of metallurgy and head of mineral technology at the Pennsylvania State College on May 1. Announcement of the appointment was made by Edward Steidle, dean of the school. Dr. Gensamer holds a U. S. patent for the manufacture of non-aging steel, has served as galvanizing foreman, chemist in charge of laboratory, and acting chief metallurgist in charge of all heat treatment and galvanizing for the Page Steel and Wire Company, Monessen. His professional association with Carnegie Tech began in 1929 when he was a graduate student and research assistant in the metals research laboratory. In 1943 he was made professor. He has served on numerous advisory commit-



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Salt water has its place—but it's not in your oil well! And it's easy to make a fluid-tight seal that bars it out. Just do two things — one, when you run casing put on enough B and W Wall Cleaning Guides to really clean the walls of mud cake and debris and, two, move the casing while cementing. Result: a solid wall of cement, well bonded to the formation . . . no thin spots, no channeling, no salt water. And no recementing!

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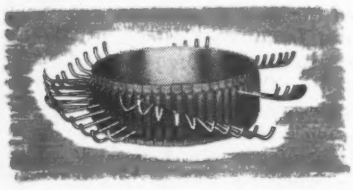

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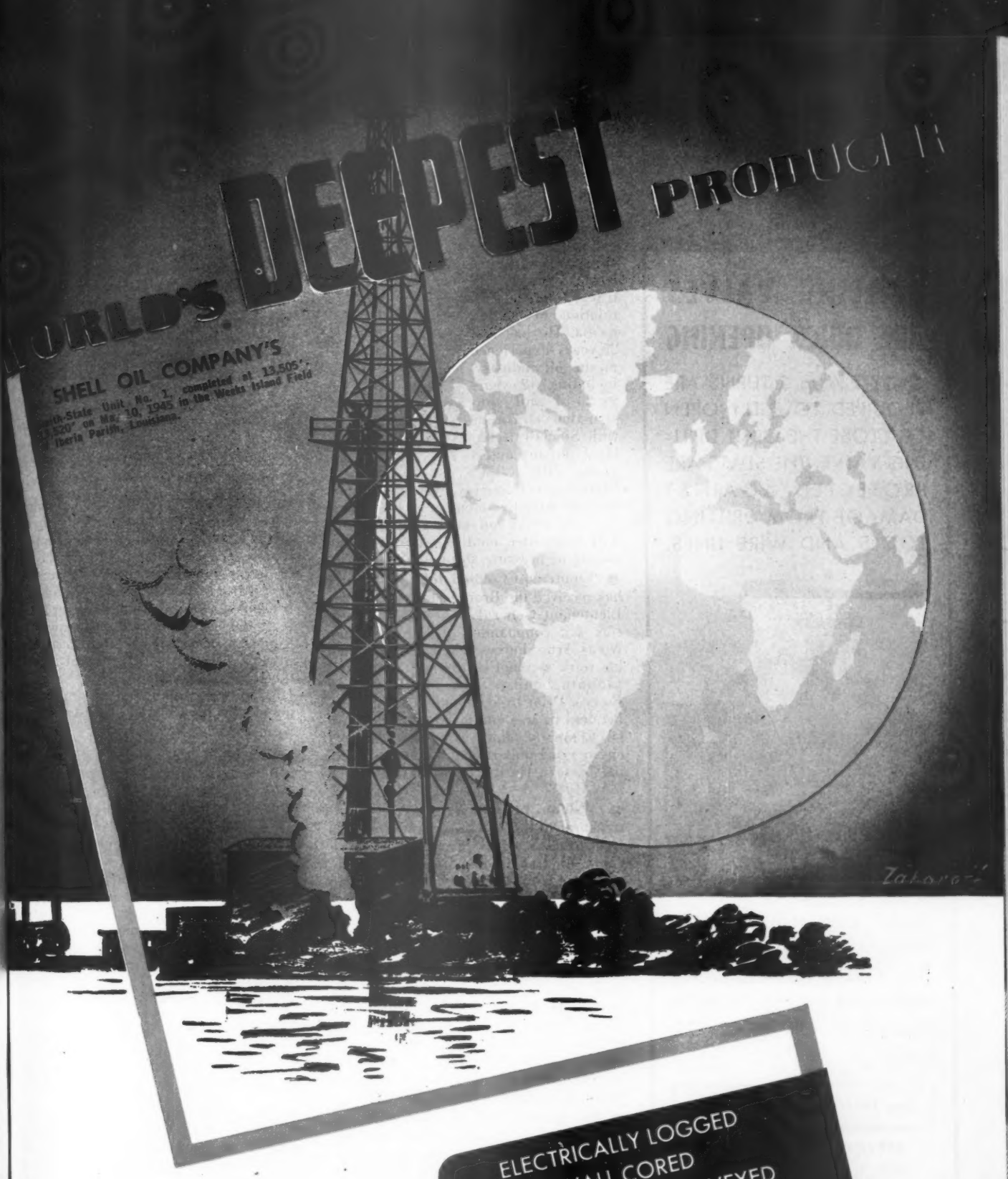
WORLD'S DEEPEST PRODUCER
SHELL OIL COMPANY'S
South-State Unit No. 1, completed at 13,505'
(13,520' on May 10, 1945 in the Weeks Island Field
Iberia Parish, Louisiana.
Zaborac

ELECTRICALLY LOGGED
SIDE WALL CORED
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SCHLUMBERGER
...ALL THE WAY!

SCHLUMBERGER WELL SURVEYING CORPORATION
HOUSTON, TEXAS

ORBIT VALVES

DRILLING VALVES ARE QUICK OPENING

ONLY 2½ to 5 TURNS ARE REQUIRED TO FULLY OPEN OR CLOSE THE ORBIT DRILLING VALVE. THE SEATS ARE PROTECTED AGAINST DAMAGE FROM DRILLING TOOLS AND WIRE LINES.

Orbit Flanged End Drilling Valve

ORBIT DRILLING VALVES ARE AVAILABLE IN BOTH FULL OPENING AND NOMINAL OPENING SIZES. WITH FLANGED OR SCREWED ENDS.

See 1944 Composite Catalog

SERVICE REPRESENTATIVES

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Phone Fairfax 0057

Warehouse: 407 Velasco Street
Houston

Earl F. Warren, Phone 919-W,
Alice, Texas

Rex E. Galloup, Phone 6436,
Lubbock, Texas

ORBIT VALVE COMPANY
TULSA, OKLAHOMA

tees of the National Defense Research Council and has published many research findings in professional and scientific journals.

● **V. B. Nelson,** consulting engineer, announces the opening of offices at 2132 Commerce Building, Houston, Texas, specializing in the calibration of pressure vessels, ships, barges, tanks and trucks, and the correlation of gaging media. He has had 20 years' experience in the oil industry, including 12 years as field and construction engineer with Sinclair Refining Company and 8 years with E. W. Saybolt and Company. Nelson will continue as an active member of the ASTM advisory group on gaging and on the API committee on the calibration and gaging of pressure storage.

V. B. Nelson

● **Lieutenant Colonel John G. Towner** has received the Bronze Star medal from Lieutenant General Robert C. Richardson, Jr., commander of Pacific Ocean Areas Army Forces. The citation lauded his work as chief of the operations and planning subsection, Pacific Ocean Forces. Prior to to Colonel Towner's enlistment he was employed with the Pure Oil Company, Olney, Illinois, in the civil engineering department, Illinois producing branch. He has been overseas since May, 1942.

● **William L. Dankmyer,** 67, assistant treasurer of the Allegheny Ludlum Steel Corporation, Brackenridge, Pennsylvania, died at his home on May 27. He had been with Allegheny Ludlum for 33 years and had been assistant treasurer since April 28, 1939.

● **J. C. Schaefer,** field engineer of the Allis-Chalmers Pittsburgh district office, has been appointed branch office manager at Youngstown, Ohio. He will succeed **E. H. Legler,** who has been transferred to the electrical department, Milwaukee, Wisconsin. **L. E. Stacey,** field engineer of the Pittsburgh district office, has been transferred to Wheeling, West Virginia, as a resident field engineer.

● **Dr. Lester M. Goldsmith,** chief engineer of The Atlantic Refining Company, has been elected chairman of the Philadelphia section of the Society of Naval Architects and Marine Engineers. The first meeting of the section under his chairmanship was held May 18. **Professor Kenneth L. M. Davidson,** director of the Stevens Institute of Technology's experimental towing tank, Hoboken, New Jersey, was the principal speaker.

● **Dr. Charles E. Skinner,** founder of the Westinghouse Research Laboratories, who recently retired as a civilian consultant of the Army Signal Corps, was honored recently by his former Westinghouse Electric Corporation associates at a dinner marking his eightieth birthday. He had been retired from the company 10 years prior to his accepting the army's call to service in April 1943. **Captain Leonard B. Loeb,** navy scientist and one of America's most distinguished physicists, on leave from the University of California, delivered the main address.

● **A. H. Mitchell,** manager of the personnel and industrial relations department of The Carter Oil Company, was elected a director of the company recently, according to O. C. Schorp, president. **W. M. Barnhill,** assistant treasurer of the company, becomes treasurer. With the company for 25 years, Barnhill has served as assistant treasurer since 1934. He succeeds **C. D. Mills,** New York City. Mitchell began his service with Carter in February 1927 and has worked as a roustabout, well tester, construction engineer, chief clerk, and head of the personnel and industrial relations department, the latter since October 1937.

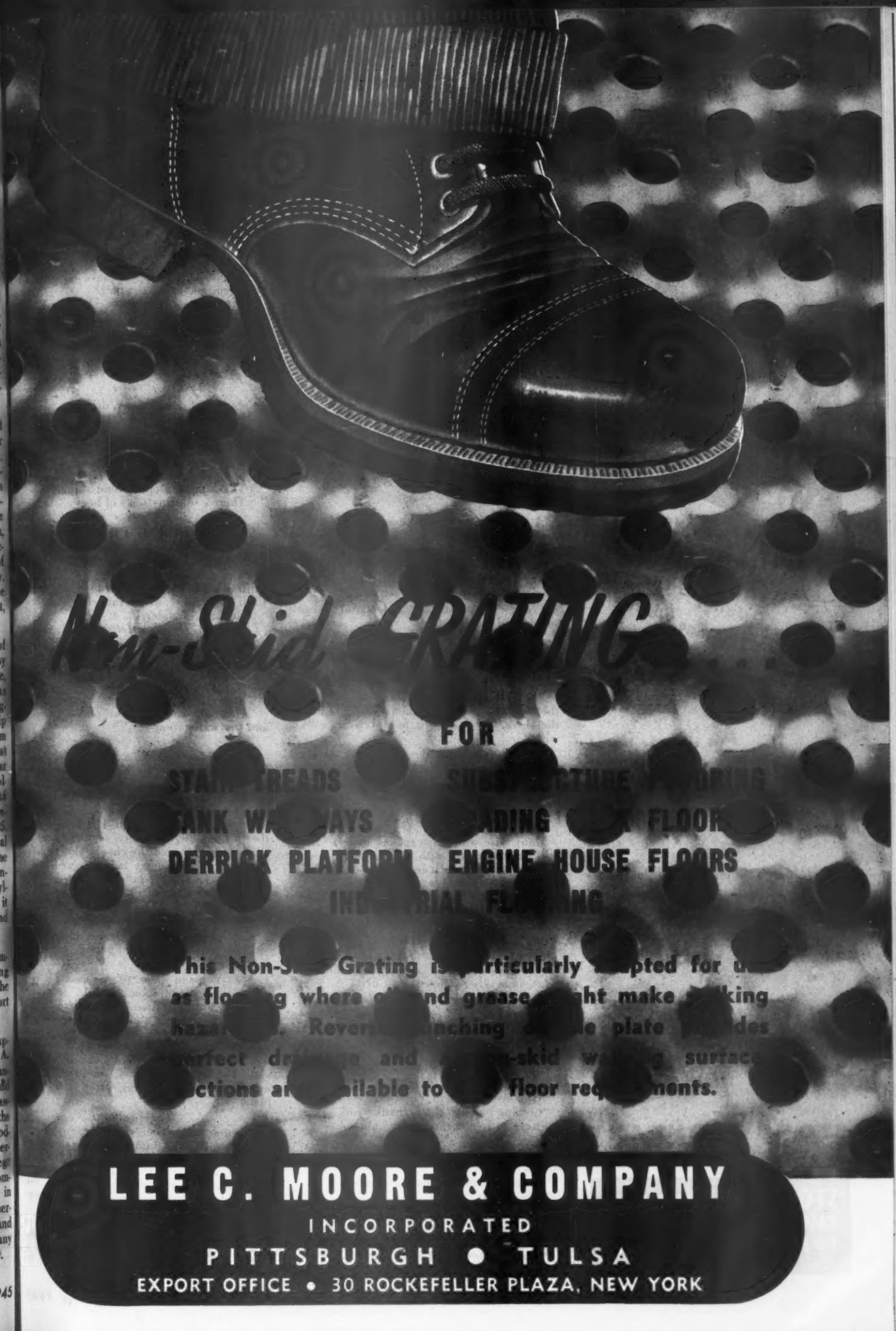
● **John Paul Aprea** has been appointed advertising and public relations director of the Eutetic Welding Alloys Company. Aprea, recently discharged from the armed forces, is well prepared to assume his new duties. He has served as advertising and sales promotion manager for the National Manufacturing Corporation, Tonowanda, New York, and as an executive in the advertising department of the Ruberoid Company, New York City. He will maintain headquarters at the home office of Eutetic, 40 Worth Street, New York 13, New York.

● **Dr. Paul H. Giddens,** department of history and political science, Allegheny College, Meadville, Pennsylvania, has been awarded a Guggenheim Fellowship that will release him from his duties at Allegheny next year to write another volume on *The Growth of the Petroleum Industry 1870-1895.* The work will deal primarily with the leadership maintained by Pennsylvania in the petroleum industry until it lost its leadership to West Virginia and Ohio.

Dr. Paul H. Giddens

● **W. F. Herbert** of The Texas Company spoke on "Design of Casing Strings," recently at the luncheon of the Petroleum Engineers' Club in Fort Worth, Texas.

● **Charles F. Codrington** has been appointed assistant to the manager and **A. E. Caudle** has been appointed sales manager of the Allis-Chalmers blower and compressor department, it has been announced by John Avery, manager of the department, Milwaukee, Wisconsin. Codrington received an electrical engineering degree from Texas A. & M. College and worked for the Badger Motor Company before joining Allis-Chalmers in 1930. Caudle is a mechanical engineering graduate of Oregon State College and worked for the Badger Motor Company before joining Allis-Chalmer in 1939.



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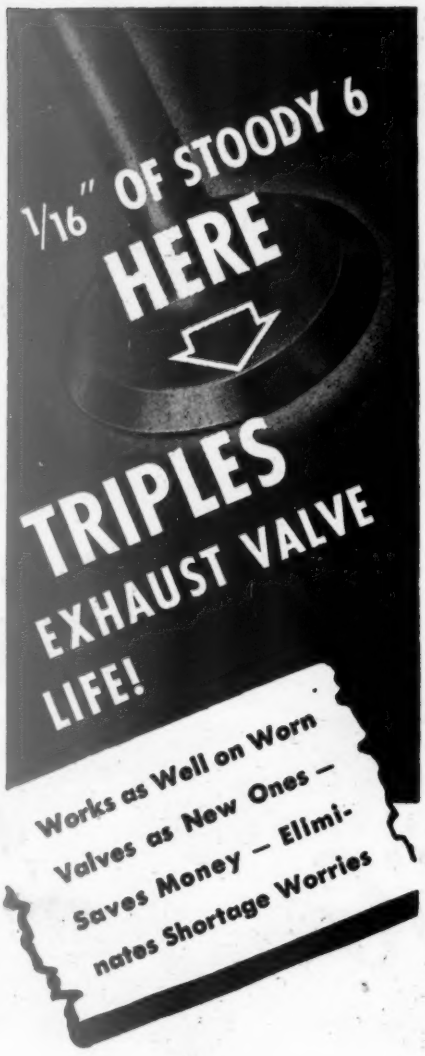
PITTSBURGH • TULSA
EXPORT OFFICE • 30 ROCKEFELLER PLAZA, NEW YORK


1/16" OF STOODY 6
HERE
TRIPLES
EXHAUST VALVE
LIFE!
Works as Well on Worn Valves as New Ones — Saves Money — Eliminates Shortage Worries

AN ounce or two of Stoody 6 welded to new or worn exhaust valve faces adds 300 to 400 percent to their normal life, prevents burning, saves overhaul jobs, costs only a few cents per valve.

This folder outlines the simple procedure any garage or shop equipped with acetylene welding equipment can follow. Eliminates your worries about valve replacements and saves money as well.

Write for folder "Weld New Life Onto Worn Valves With Stoody 6" — no obligation.

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1142 SLAUSON AVE., WHITTIER, CALIF.

STOODY 6 - THE METAL THAT ADDS EXTRA MILES TO EXHAUST VALVE LIFE!

LAUGH WITH BARNEY

"You look all in today, Bill. What's the trouble?"

"Well, I didn't get home until just daylight, and then my wife woke up while I was undressing. She asked me if I wasn't getting up rather early, and in order to avoid trouble I just put my clothes on and came down to the office."

* * *

The man was determined to pass the tavern on the way home without stopping in. As he approached the place, his resolve weakened, but finally with a masterful effort he passed on. Then after going a full block he stopped and congratulated himself: "Well done, old boy. Now come back to the tavern and I'll treat you to a snort!"

* * *

Medical Officer: How's Sgt. Saunders this morning?

Nurse: I think he's regaining consciousness. He tried to blow the foam off his medicine.

* * *

A wedding ring is like a tourniquet—it stops circulation.

* * *

Lady customer in shoe store: Of course, I want them comfortable, but at the same time good looking and attractive.

Clerk: Yes, madam, I understand—large inside and small outside.

* * *

At the Teheran Conference, Premier Stalin told a story that still has diplomats laughing.

"The neighbor of an Arab sheik asked for the loan of a rope. 'I cannot lend it,' replied the sheik, 'for I need it to tie up my milk with.'

" 'But surely,' said the other, 'you do not tie up your milk with a rope.'

" 'Brother,' said the sheik, 'when you don't want to do something, one reason is as good as another'."

* * *

Many wise words are spoken in jest—but they can't compare with the number of foolish ones spoken in earnest.

* * *

Old "Wolf": You look so sweet I could eat you.

She: The 'ell you could, you haven't any teeth!

* * *

Lots of people know a good thing the moment some other fellow sees it first!

* * *

Corporal to taxi driver: What are you stopping for?

Taxi driver: I thought I heard the young lady say stop.

Corporal: Well, she wasn't talking to you.

* * *

"How's your patient, Captain?"

"Coming along fine, thank you. This morning he took a turn for the nurse."

* * *

"I had to change seats several times at the movies."

"Gracious, did a soldier get fresh?"

"Yes, finally."

* * *

She: Oh, he's so romantic. When he addresses me he always calls me "fair lady."

Friend: Force of habit, my dear; he's a street-car conductor.

They tell of the two ambitious little fleas who worked hard and saved their money and finally went out and bought their own dog.

* * *

Embarrassed young man: Er-ah-sir-I-er that is—I came to say that your daughter tells me that she-er loves me.

Parent: Oh! And you have come to ask my permission to marry her?

Embarrassed young man: No, sir; I came to ask you to make her behave.

* * *

"I want to die with my boots on," boasted the salesman. Said she, "Well, put 'em on! Here comes my husband."

* * *

She: No, I don't smoke, drink, or neck.

He: Well, then, what do you do?

She: I tell lies.

* * *

The queen bee is a hardy soul,
She thumbs her nose at birth control.
That's the reason, beyond a doubt,
There's so many son's of bees about.

* * *

CEILING PRICES

Sign in the Blue John Coffee Shoppe:

Chili	15c
Chili in a bowl	20c
Chili in a bowl with crackers	25c
Chili in a bowl with crackers, spoon, and glass of water	30c

(Thanks to Joe W. Melton, University of Texas)

* * *

"Boss, I must have a raise in salary—three other companies are after me."

"Name them."

"The light company, the phone company and the water company."

* * *

A salesman making a two weeks stay in town, bought some limburger cheese to eat in his room. When he got ready to leave, he still had about half of the cheese left. He didn't want to pack it nor did he want to leave it lying in the room. He went over to the windowsill, carefully removed a plant from its pot, buried the cheese and replaced the plant. A few days later, he received a telegram from the hotel: "We give up; where did you put it?"

* * *

Diner: Waiter, there's a fly in my soup.

Waiter: That's no fly, that's one of those vitamin bees you've heard about.

* * *

A Frenchman came to America to learn the language and soon got into difficulties with his pronunciation, especially with the group comprising "though" "plough" and "rough."

When the film "Cavalcade" began its run, one newspaper review was headed " 'Cavalcade' Pronounced Success," and the Frenchman gave up the struggle and went back home.

* * *

A purchasing agent who requested a supply house to send him a new catalogue received this reply:

"The only part of our catalogue we are still certain about is the line that says, 'Est. in 1885.' All other information and prices have been withdrawn."

* * *

She was just a second-hand dealer's daughter and that's why she wouldn't allow much on the old sofa.

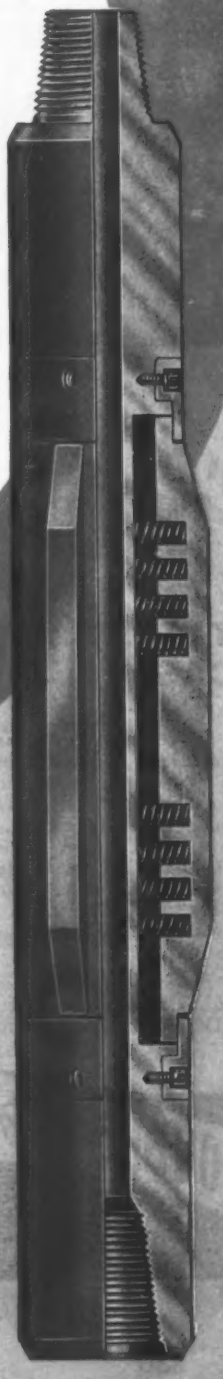
SCRAPE THE CASING

The Baker Rotary Casing Scraper is rapidly growing in popularity as operators discover how easily and how thoroughly it scrapes and cleans the inside walls of the casing. While the rotary equipment still is in place, the "working surface" of your casing should be cleaned of all hardened cement and scale—all burrs left from gun perforating should be removed. This leaves the inside of your casing clean and smooth for all future work. Packers and swabs can be set or operated without damage to the rubbers.

The Baker Rotary Casing Scraper is simple and strong in construction, is readily made up in the string, and does its work easily and safely. It is serviced on a rental basis in the United States; sold elsewhere; and full details will be found on Page 357 of the Composite Catalog. Or, write Baker Oil Tools, Inc., at Houston, Los Angeles, or New York, for your copy of the 1944 Baker Catalog.

BAKER OIL TOOLS, INC.

TO GET A BETTER WELL



BAKER
ROTARY
Casing Scraper

Opens Dallas branch

The General Detroit Corporation with factories in Detroit, Michigan, and Los Angeles, California, has opened a factory branch warehouse in Dallas, Texas. E. A. Warren, executive vice president and treasurer, was in charge of the opening activities, along with S. M. Luce, southern sales manager for the company. F. D. Bacon, general sales manager and an ex-oil company official, visualizes the Dallas branch as being of great importance to the oil field industry in the Southwest. The company, manufacturers of fire fighting equipment, carries a complete warehouse stock at the new branch, consisting mainly of portable fire extinguishers of all types including carbon tetrachloride, carbon dioxide types in all sizes, foam type extinguishers, and water types. The company's line is Underwriter Laboratories, Factory Mutual approved.

Merchandising to the oil industry is through such distributors as Continental Supply Company, Peden Iron and Steel, Hart Industrial Supply, and others of equal importance throughout the Southwest.

General Detroit Corporation maintains a complete staff of "fire protectioneers" who are specialists in their field. They are at 2120 Jackson Street, Dallas, Texas.

New Eastman office

The Eastman Oil Well Survey Company announces the opening of an office in Victoria, Texas. In charge will be field service representative, B. Frank Johnson.

Vogler appointed

Arthur V. Danner, executive vice president of the Houdry Process Corporation, Wilmington, Delaware, has announced the appointment of W. E. Vogler as director of industrial relations and personnel. Mr. Vogler has been consultant to industry on industrial relations for many years. As Director of Personnel at Purdue University, one of the country's largest engineering schools, he developed an intensive industrial relations program for that school. Prior to his experience at Purdue, Mr. Vogler had been for twelve years personnel manager of the Albany Division of Socony-Vacuum Oil Company, Inc., covering upper New York State and part of New England.

W. E. Vogler

Fairman named manager

F. E. Fairman, Jr.

Food Machinery Corporation has made two major changes in its executive set-up. Clarence M. Frazier, vice president, who has headed Peerless Pump Division of the corporation for the last 18 months, returns to the corporate headquarters, in San Jose, California, to assume more important work in connection with the overall management.

Francis E. Fairman, Jr., formerly a General Electric executive, was named manager of the Peerless division and a vice president of Food Machinery Corporation.

Controlled
PRESSURE
EXPANSION

ASSURES FULL FLUID RECOVERY WITH MINIMUM WEAR ON CUPS

"DOUBLE E"
TUBING CASING SWABS

By reducing cup wear, the cost of swabbing is materially reduced. That's why the "DOUBLE E" SWAB is a money-saver . . . it has an exclusive controlled expansion feature which greatly reduces the wear on cups, at the same time provides for FULL fluid recovery. The load on the "DOUBLE E," regardless of the depth well, is 75 per cent less than that on other cup type swabs. The "DOUBLE E" is called the One-to-Four Swab, because the cups outlast ordinary cups one to four.

Sold through supply stores everywhere, in sizes ¾ to 10¾ inches, all with the same exclusive "DOUBLE E" cup design.

"DOUBLE E" Products

E. A. Doyle dies

Edmund A. Doyle, consulting engineer for The Linde Air Products Company, a unit of Union Carbide and Carbon Corporation, and a former president of the American Welding Society, died at his home in New York City recently. He was 64 years old.

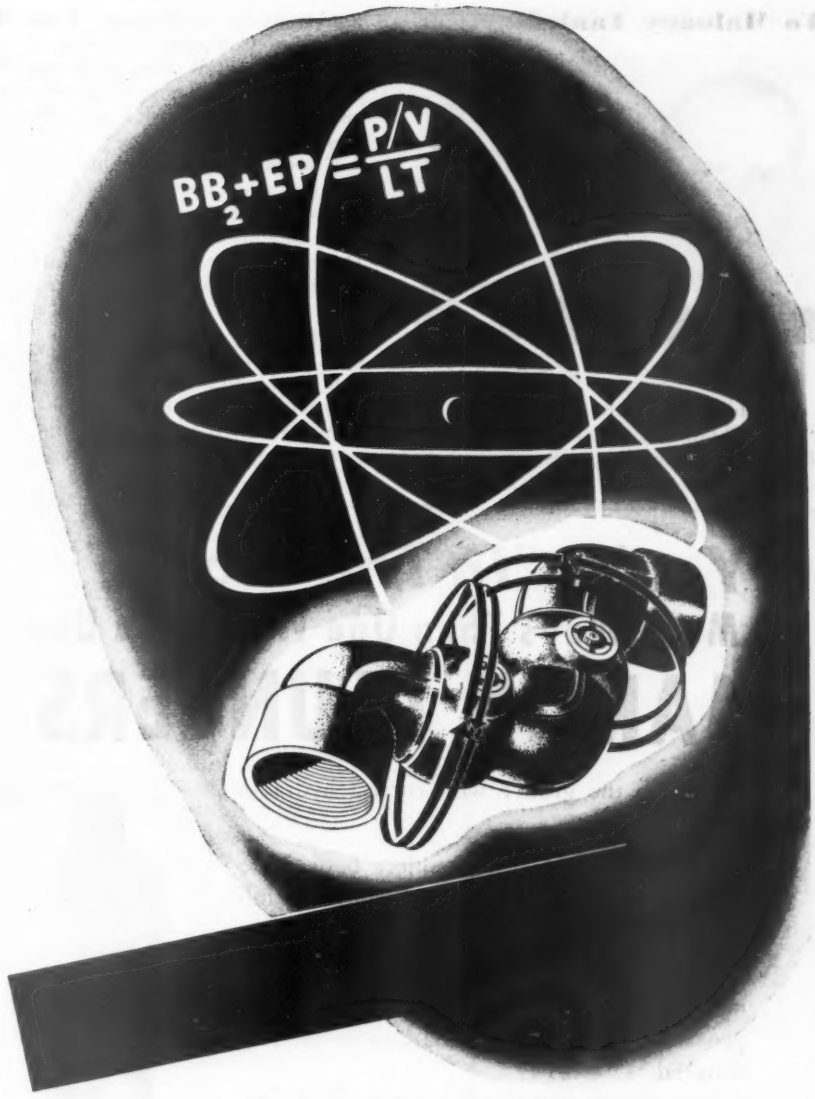
Doyle began his association with The Linde Air Products Company in 1922 as assistant general sales manager in charge of service. Four years later he became consulting engineer on process development, a position he held until his death.

Joins Westcott and Greis

Dean D. Ault

Dean D. Ault has joined the Westcott and Greis division of American Meter Company as field engineer, with headquarters at Houston, Texas. Ault is well known and highly regarded for his work on recording instruments and automatic control applications in the gas and petroleum industries, and remote automatic control and loading of natural gas regulators.

Ault served in the U. S. Navy in World War 1. He is a graduate of the University of Arkansas, class of 1924, and of the Chicago Central Station Institute. He holds the degree of bachelor of electrical engineering.



BB_2 = Double rows of Ball Bearings
EP = Effective Packing Element
P/V = Pressure or Vacuum
LT = Low Torque under all conditions.

Perfect flexibility with low torque is assured in every CHIKSAN *Ball-Bearing* Swivel. Yet Chiksan design and construction are so sound they can be expressed in a simple formula. There is nothing to tighten or adjust... no stuffing boxes to put the brakes on easy turning and thus produce excessive strains on pipe lines and fittings. Smooth, easy turning throughout 360° is provided in one, two and three planes. Packing Element is so effective the same Swivel may be used for either pressure or vacuum service... for loading or unloading. Chiksan *Ball-Bearing* Swivels are built for pressures to 3,000 p.s.i. and varying temperatures. Write for latest catalog.

Chiksan Representatives in Principal Cities

CHIKSAN TRADE MARK REG. BALL BEARING SWIVEL JOINTS FOR ALL PURPOSES

CHIKSAN COMPANY
BREA, CALIFORNIA

To Maloney Tank

O. W. Maloney

H. D. Crawford

Harold D. Crawford will move to Tulsa, Oklahoma, from Dallas, Texas, shortly to assume the duties of secretary and treasurer of Maloney Tank Manufacturing Company, of Tulsa, it is announced. J. S. Warren, chairman of the board, has sold his stock interest in the company to Crawford, as has Mrs. Harry Ross.

Crawford is severing his official connection with the Crawford Tank and Supply Company, of Dallas, of which he is president. He is the son of the late David Crawford of Parkersburg, West Virginia, who with his brother John established the Parkersburg Rig and Reel Company.

O. W. Maloney will continue as president and chief executive officer of the company. He is the son of the founder, O. W. Maloney, Sr., who was the original patentee of the bolted steel tank.

Warren, who relinquished active management of the company 3 years ago, becoming chairman of the board and treasurer, will retire from the organization after more than 30 years' service, 20 of which he served as general manager.

J. C. Highfill will remain as vice president and general manager. The company has been in continuous operation in Tulsa since 1915. Maloney Tank Company has devoted a major portion of its productive capacity during the war to making tanks and portable airplane landing field strips for the various armed forces.

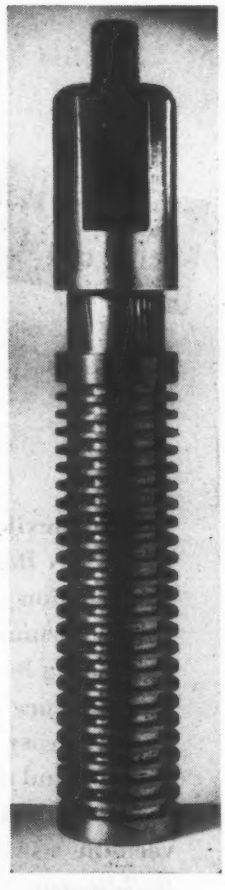
The firm now offers for both domestic and export trade a complete line of bolted steel tanks, welded steel tanks, oil and gas separators, heaters and treaters.

The company plants No. 1 and No. 2 are at 38 North Peoria, in Tulsa.

You're "In The Groove"
In More Ways Than One When You Use
MARTIN PLUNGERS

- You're in the groove with correct hydraulic engineering.
- Your grooved, Martin one-piece body is accurate, rigid, fluid-proof and more durable than any other ring type body.
- Your Martin Rings perform uniformly and last much longer because of their accuracy and compensation for thickness variations in the ring material.
- Your pump-tubes and working barrels will last longer.
- You're in the groove for greater overall pumping efficiency and economy.

Martin Plungers are made to fit any size or make of pump—more than 300 different lengths, diameters and thread combinations.



Martin Plunger Body After Four Years' Use.

Write for Illustrated Catalog or See Page 1799, Composite Catalog

SOLD ONLY THROUGH SUPPLY STORES

JOHN N. MARTIN
Manufacturer
11 W. Brady St. Tulsa, Okla.

Field Representatives

Tom Hulett, El Dorado, Ark.
A. W. Branscum, Tulsa, Okla.
C. J. Baeten, Wichita, Kansas
F. M. Wilson, Wichita Falls, Texas
Mrs. Lynn Holloway, Houston, Texas
J. Walter Wade, Chicago, Illinois
E. C. Dilgarde, Casper, Wyoming

Daniel Orifice engineer

John Whalan

John Whalan has recently been appointed chief engineer of the Daniel Orifice Fitting Company, Los Angeles, California.

Whalan is a familiar figure in the oil and gas industry, having been associated until a short time ago with a large West Coast firm in the capacity of chief engineer in charge of all engineering including design, experimental, development, and research work. Whalan will have complete charge of all engineering details at Daniel.

New laboratories

A plant that started almost a half century ago in an 80 ft. by 100-ft. building and grew into 625,000 sq. ft. of manufacturing space, formally opened its new engineering laboratories at Rockford, Illinois, recently. The concern is Rockford Clutch (formerly Rockford Drilling Machine) Division of Borg-Warner, which is operating testing and research facilities established in Rockford originally by the parent organization.

Announcing the acquisition, President Arch A. Warner made known that not only development and designing engi-

neers, but the company's sales experts, "able to analyze the various requirements which result in the design and manufacture of more suitable clutches," already have occupied the laboratory in the research unification move.

"As soon as possible," Warner said, "additional machinery and testing equipment for clutches in eight distinct fields served by Rockford Clutch will be installed, and clutches for every purpose designed, developed, and tested in the laboratory as well as in the field."

Traner passes

Emil C. Traner, veteran Rockford industrialist and supervisory board chairman of Rockford Clutch Division, Borg-Warner, died at his home in Rockford, Illinois after an extended illness. He was 68 years old.

Traner was born in Rockford August 19, 1876, and spent his entire business career there, retiring last November as president and general manager of Rockford Clutch, formerly Rockford Drilling Machine Company, which he joined as secretary in 1916.

Schlumberger changes

J. L. Mathieu, former general sales manager for Schlumberger Well Surveying Corporation, has found it necessary to relinquish his duties in order to devote his entire time to exploitation and rehabilitation of the Schlumberger company operating abroad.

The duties relinquished by Mathieu will be assumed by E. F. Stratton, who for 10 years has managed the Illinois division of the Schlumberger Well Surveying Corporation. Stratton will make his headquarters in Houston.

C. A. Doh, former district engineer in Mt. Vernon will replace him as manager of Illinois operations with the help of H. A. Nystrom, assistant manager.

Macwhyte appointments

R. P. Tyler, general sales manager of Macwhyte Company, Kenosha, Wisconsin, has appointed Fred M. Sime as district sales manager for the Pacific Southwest and William J. Brett district sales manager for the Pacific Northwest.

Sime is at Macwhyte Company's San Francisco office, 749 Bryant Street. Brett is at the company's Portland, Oregon, office, 1603 N. W. 14th Avenue.

Eastman chief engineer

J. Gordon Jackson

J. Gordon Jackson has been promoted to chief engineer of all Eastman Oil Well Survey Companies. He has recently returned to Long Beach after an extended tour of all the producing areas in the United States. Jackson joined the Eastman organization in 1939 and has had experience in all departments of the company.

Crane promotes

Crane Company has announced the following changes in its sales and branch house division, effective June 16: Carter T. Pollock, formerly manager of Crane's Chicago branch, is appointed manager of the central district with headquarters in Chicago; W. A. Burbine, formerly manager of the company's Cleveland branch is made manager of the Chicago branch; A. N. Rosborough, formerly manager of the Toledo branch is appointed manager of the Crane branch in Cleveland; W. D. LaRue, manager of the Muncie, Indiana, branch is promoted to the managership of the Toledo branch, and R. C. Danielson, formerly manager of the plumbing department at the Indianapolis branch is made manager of the Muncie branch, replacing LaRue.

Sperry-Sun representative

The Sperry-Sun Well Surveying Company of Philadelphia, but with sales and service offices in Houston, Corpus Christi, Marshall, Odessa, Texas; Lafayette, Louisiana; Long Beach, Bakersfield, California; Oklahoma City, Oklahoma, and Casper, Wyoming, have just announced the appointment of the Moulden Oilfield Services as their exclusive representatives in the Rocky Mountain territory. This covers the states of North Dakota, South Dakota, Montana, Wyoming, Utah and Colorado, and the northwestern part of New Mexico. Headquarters of the Moulden Oilfield Services is 329 South McKinley Street, Casper, Wyoming.

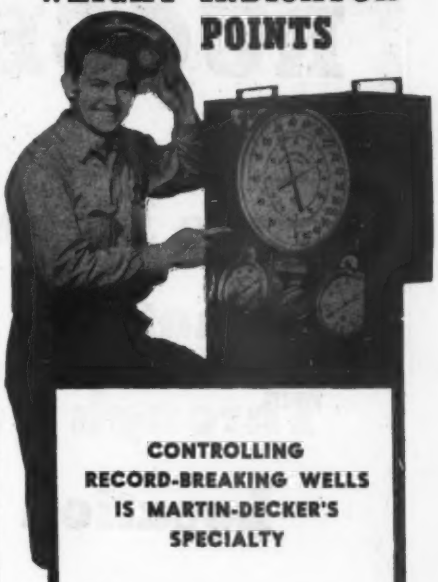
The Moulden organization is headed by Carl Moulden, formerly associated with Manning and Brown, who are one of the well-known and highly regarded operators in this territory. Moulden is a graduate of the Texas A. & M. College and has had many years' practical experience in drilling operations. He is thoroughly experienced and will advise in the selection and use of the Sperry-Sun Well Surveying Company's instruments and technical services, which include the multishot surveys made with the Surwel Gyroscopic Clinograph, rentals of the Syfo Inclinometer, the E-C Inclinometer and the directional single shot instrument and Polar Core Orientation service.

Overman appointed

Thermoid Company, Trenton, New Jersey, announces that H. W. Overman has been placed in charge of industrial friction materials. Overman's experience well qualifies him for his new duties. Previous to his recent association in his father's business, he was with Ferodo Asbestos, Inc., for 9 years. During the last 4 years with Ferodo, he was in charge of original equipment sales to both industrial and automotive customers. He is a mechanical engineer and a member of the Society of Automotive Engineers.

Overman's appointment marks another step in Thermoid's program to expand its engineering service and sales of friction blocks to industry.

WEIGHT INDICATOR POINTS



CONTROLLING RECORD-BREAKING WELLS IS MARTIN-DECKER'S SPECIALTY

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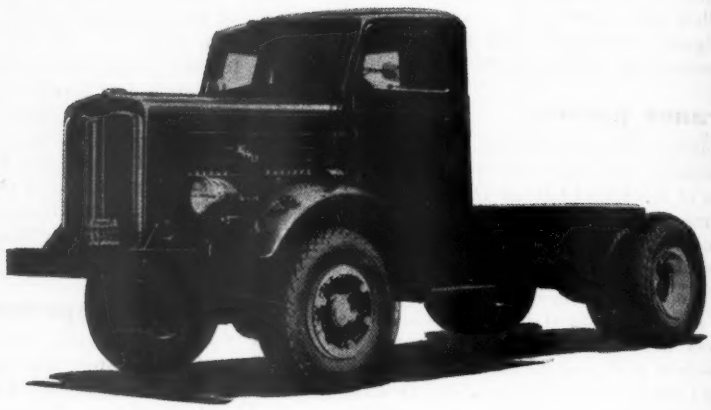
Prime Movers That Get Through To Location



Oil-field operations make heavy demands on men and equipment. Motor trucks particularly are expected to stand up under exceptionally tough duty — get men and heavy equipment through to location, regardless of weather and without benefit of paved highways.

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THE FOUR WHEEL DRIVE AUTO COMPANY
Clintonville, Wisconsin
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PAULSBORO TCC UNIT DESIGNED FOR TREATING OR REDUCED CRUDE CRACKING OPERATIONS

By **JOHN H. KUNKEL,** *Refinery Editor*

PART 3 (Conclusion) PRINCIPAL CONTROLS

EXCLUSIVE THE basic rate of fresh feed and recycle flow, the combination of which forms the total charge to the Paulsboro TCC vaporizer furnace in treating operations, is established by 2 rate-of-flow controllers. One is installed in the fresh feed line between the fresh feed pump and the fresh feed heat exchanger, the other in the recycle transfer line between the recycle pump and the junction of the fresh feed and recycle lines at the inlet of the vaporizer furnace.

As previously mentioned, the flow of the combined charge splits into 4 parallel streams for pass through the vaporizer furnace. The division of the combined charge, into 4 parallel streams through the furnace is accomplished by 4 hand-controlled valves with indicating flow meters installed on the upstream side of each valve. As the rate of flow has previously been established, rate-of-flow controllers are not required at this point. Automatic firing control of each individual pass is by means of a furnace outlet temperature controller with thermocouple element installed in each of the 4 lines near its respective outlet. The usual recording and indicating potentiometer points are provided at intermediate points to transmit temperatures of oil and flue gas.

● **Cracking operations.** It will be recalled that, in cracking operations, flow is from the vaporizer furnace through a tar-stripper and then through the superheater before entering the reactor.

A temperature controller on the tar-stripper regulates its top temperature by throttling the amount of reflux over the stripper top. The stripper bottoms cold tar recycle stream is under control of a liquid-level controller. A liquid-level controller installed on the stripper's down-flow draw-off pan controls the rate of flow pumped from the draw-off pan back to the transfer line from the vaporizing furnace to the stripper, or for transfer of hot tar to mix with the fractionator bottoms.

The superheater is equipped with the usual indicating and recording potentiometer points on both the oil and flue gas side. An automatic firing controller maintains the outlet temperature at the level required by the operation being conducted.

● **Reactor and kiln diagram.** A feature of the main control room instrument panel is a diagram of the reactor, catalyst elevators, and thermofor kiln. The left-hand side of the diagram is an outline of the catalyst hopper and reactor showing vapor lines, the purge steam line, the seal line, and the catalyst lines. The center is devoted to the reactor and kiln catalyst elevators. The right-hand side is a diagram of the thermofor kiln superimposed on a graphic temperature indicating potentiometer. Twenty manually-operated flag indicators are installed on this section to show the position of the hot air and flue gas dampers. The entire diagram is arranged to provide the operators with a complete picture of the operation being conducted by means of red, green, and white lights, the potentiometer readings and the damper flags.

● **Reactor controls and lights.** Bypassing and/or blocking off the oil vapors from or around the reactor is accomplished by three motor-operated valves.

A description of the controls that are vital to the operation of a thermofor catalytic cracking unit.

Manually-operated switches, mounted on the panel, are provided to open or close these valves. A fourth switch controls the interlock. Open valves are indicated on the reactor and kiln diagram by a green light whereas red lights indicate closed valves.

As a seal at the top of the reactor, to prevent escape of oil vapors into the feed hopper, a differential pressure controller maintains a ½ lb. differential pressure between the oil vapor disengaging space and the catalyst distribution section. If a loss of seal occurs, an audible alarm sounds and, by pneumatic and electrical means, the differential pressure controller closes the catalyst valves at the top and bottom of the reactor until the seal is restored or the catalyst valves are manually opened.

A rate of flow controller alarm is installed on the superheated steam line into the bottom of the reactor. If a loss in steam flow occurs an audible alarm sounds, a red light glows on the panel, and the catalyst valves close until steam flow is restored or until the catalyst valves are manually opened.

A differential pressure instrument records the pressure drop across the reactor catalyst bed, and, also records the static pressure at the top of the reactor. Should the static pressure exceed 15 lb., which would result in oil vapors blowing out through the reactor hopper, an alarm sounds, a red light glows, and the catalyst valves at the reactor top and bottom close.

To depressure the reactor, when shutting down, a vent with a remote operated valve is installed on the effluent line from the reactor.

Temperature recorders are installed for various points in the catalyst bed and similar instruments are provided to record the temperature of the effluent leaving the reactor and the temperature of catalyst entering the reactor.

● **Reactor catalyst hopper.** The flow of catalyst through the kiln and reactor is controlled by 2 air pressure-actuated chopper-type valves, one of which is installed at the inlet to the reactor feed elevator and the other at the inlet to the kiln elevator. Provision is made for opening and closing these valves manually.

The catalyst level in the hopper is maintained and shown by a level indicating and recording controller. The level instrument is a motor-driven screw and paddle that pneumatically transmits to a recording and controlling instrument mounted on the main board. If the catalyst level in the hopper rises above normal, the controller opens the reactor bottom chopper valve, feeding the kiln elevator, to compensate for the increased level. A light is installed on the panel to indicate operation of clay level indicator motor.

● **Catalyst elevator controls.** The kiln feed elevator normally is started by turning the control switch on the instrument panel to "start." The motor starts on reduced voltage because an impedance coil is in series with the line in each phase. As the motor accelerates it generates counter EMF, which reduces the current. The voltage across the impedance coil therefore decreases in proportion, whereas the voltage across the motor increases in proportion, causing increase in torque and acceleration. When the voltage rises to a predetermined level, a contactor closes, thereby shunting out the impedance coil and connecting the motor on full line voltage. A dashpot timing device is installed to delay somewhat the closing of the contac-

(Continued on Page 239)

This is the third of a series of three advertisements discussing the economics of postwar remodernization.

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(Continued from Page 235)

tor. When the contactor closes a pilot valve is energized admitting air to the chopper-type valve at the reactor base, causing it to open and permitting flow of catalyst into the moving kiln feed elevator buckets.

The kiln feed elevator is stopped by turning the switch to "stop," energizing a relay that is held in by its holding contact. A second contact opens causing the chopper-type valve referred to, to close by de-energizing its pilot valve. When the chopper-type valve is fully closed, a limit switch energizes a timing relay, which in turn stops the elevator drive motor after lapse of its time setting.

Starting and stopping of the reactor feed elevator is accomplished in the same manner. The chopper-type valve at the bottom of the kiln is part of the system and functions similarly to that on the bottom of the reactor.

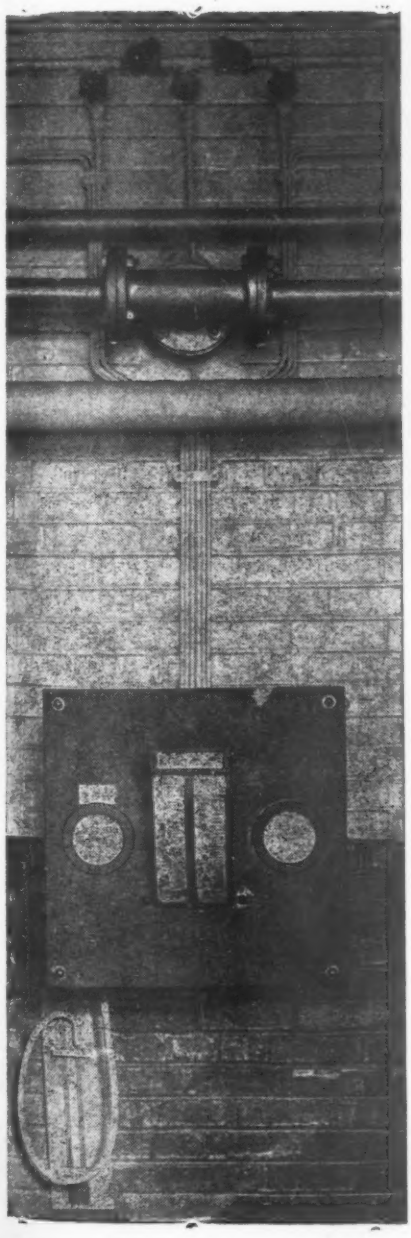
An emergency stop push button, normally used to suspend operation of the elevators, is installed on the control panel.

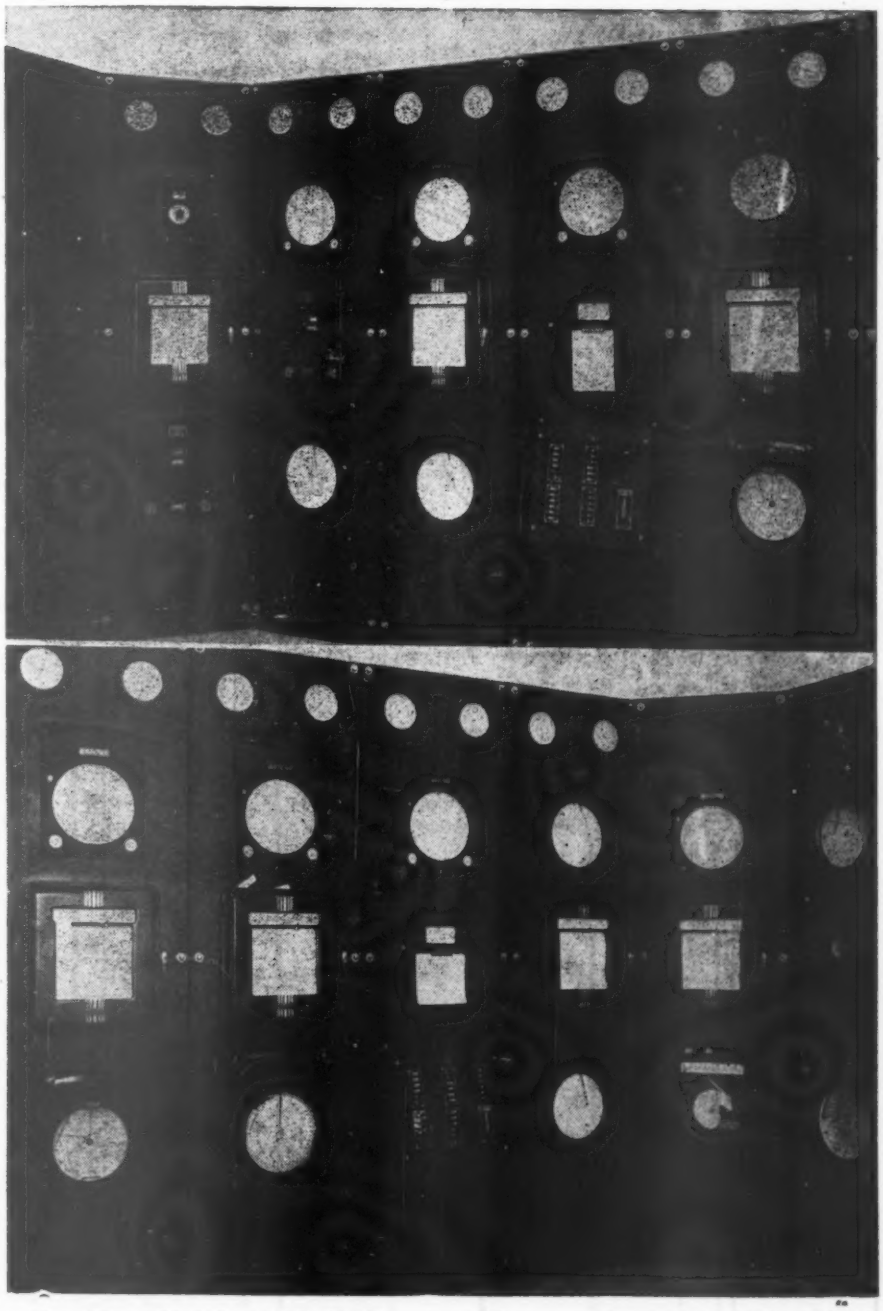
A "reset" push button is installed on the panel beneath the emergency stop button. After stoppage of the elevators by means of the emergency button, or as the result of overload, short-circuit or undervoltage, the reset button must be operated before either, or both, elevators can be restarted. Operation of the reset button energizes an undervoltage relay, which, common to both motors, has a setting of 0.8 sec. The undervoltage relay causes closure of contacts on relays on both elevator motors, each having 1.0 sec. settings. This insures that both motors will stop on a voltage drop exceeding 0.8 sec. independent of any possible uneven functioning of the individual undervoltage relays controlling the elevator motors.

As stated, the chopper-type valves are interlocked with the motor controllers so that when motors are thrown across the line by their controller, the valves open. Manual stopping of either motor first causes its feed valve to close, with the motor stopping within a definite time after the valve closes. The valves are also closed automatically due to overload, short circuit, undervoltage, or operation of the emergency push button. Lights on the diagram indicate operation or non-operation of the elevator motors.

When an elevator load exceeds normal by approximately 10 per cent, that elevator is automatically stopped by a "high" relay, the stoppage also closing the chopper valve related to that elevator. Conversely, when load decreases to approximately 90 per cent of normal, a "low" relay closes, opening the related

Air flow meter on TCC unit.





Top. **View of left-hand side, Paulsboro TCC panel.** ***Bottom.*** **View of right-hand side, Paulsboro TCC instrument panel.**

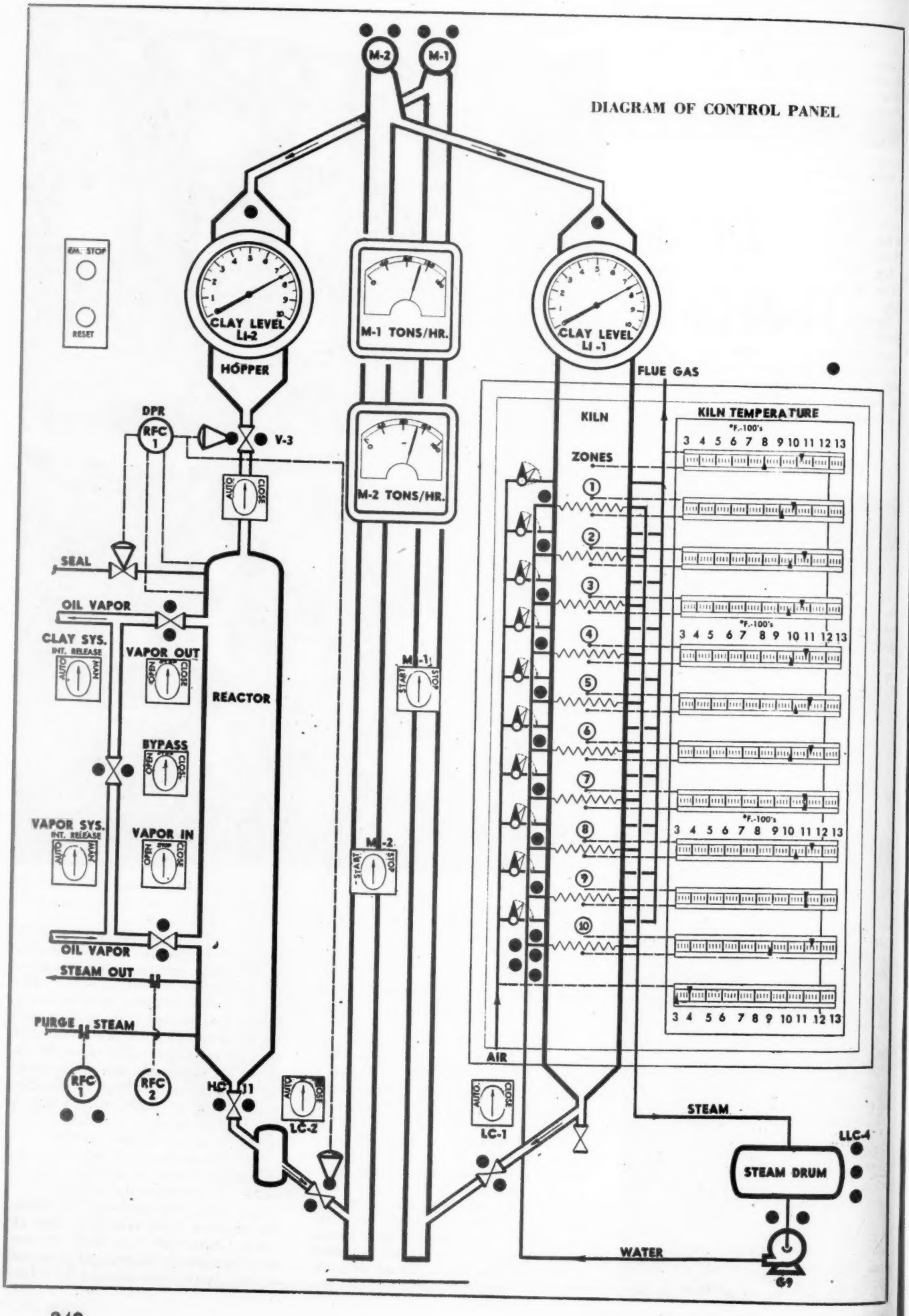


DIAGRAM OF CONTROL PANEL
M-2
M-1
EM. STOP
RESET
CLAY LEVEL
LI-2
HOPPER
M-1 TONS/HR.
CLAY LEVEL
LI -1
FLUE GAS
KILN
KILN TEMPERATURE
°F.-100's
3 4 5 6 7 8 9 10 11 12 13
ZONES
DPR
RFC
1
V-3
M-2 TONS/HR.
SEAL
OIL VAPOR
CLAY SYS.
INT. RELEASE
AUTO
MAN
VAPOR OUT
OPEN
CLOSE
REACTOR
M-1
START
STOP
BYPASS
VAPOR SYS.
VAPOR IN
M-2
OIL VAPOR
STEAM OUT
PURGE
STEAM
RFC
2
HC-11
LC-2
AIR
LC-1
STEAM
LLC-1
STEAM DRUM
WATER
G9

feed valve to restore load conditions in excess of 90 per cent.

The chopper valves may be opened or closed, independent of their interlocks, by turning their control switches respectively to "open" or "close" position. When the control switches are turned to "auto" the interlocks are automatically restored.

Two 3-phase indicating wattmeters are installed on the control panel—one for each elevator motor—to indicate the catalyst handled in tons per hour.

● **Kiln controls.** A catalyst level indicator and recorder controller, identical to that in the reactor catalyst hopper, is installed in the top of the kiln. A green light on the diagram indicates operation of the screw-and-paddle-drive motor.

The chopper valve at the kiln bottom is manually controlled to govern the catalyst rate of circulation. The rate, by means of this valve, can be varied from 50-130 tons per hr.

The potentiometer graphic temperature indicator has 12 double scales, each of which indicates the temperature at 2 points in each kiln zone, i.e., that of the catalyst entering the zone, and the temperature of the catalyst leaving the zone. Zones in use are indicated by the flags, which also show the position of the hot air and flue gas dampers. Fourteen manually-lit white lights indicate which cooling coils are in use. Should there be an excessive temperature in any one zone, an audible high-temperature alarm sounds and a red light burns to indicate the zone affected.

Below the kiln diagram there appears a representation of the steam drum and water circulating pump to show the steam and water circuit. The level in the drum is governed by a liquid-level controller with the following light combinations showing on the diagram: Green, high level; green and white, intermediate level; white, normal level; white and red, intermediate level; red, low level. A green light above the water circulating pump indicates normal pressure on the pump discharge, whereas a red light indicates a pressure drop below normal.

● **Fractionator controls.** The flow of quench from the bottom of the fractionator is governed by a recording flow controller installed downstream of the quench cooler. This functions to adjust the quench flow according to the temperature desired in the fractionator above the desuperheating baffles. Indicating potentiometer points are installed in this zone.

Each fractionator sidestream is controlled by a recording flow controller on the stripped material going to storage with release of unstripped distillate from the fractionator regulated by a liquid-level controller operating from the bottom level of each stripper.

Fractionator temperature recording and indicating points are installed at key locations in the tower to show the temperature of the tower top, each sidestream draw-off, bottom temperature, etc.

Tower top temperature is controlled automatically by a temperature controller on the reflux line that regulates the amount of reflux pumped back over the fractionator's top.

Water is released to the sewer from the gas separator automatically by an interface-type liquid-level controller, whereas transfer of unstabilized distillate is regulated automatically by a liquid-level controller on the line to storage.

Admission of the fractionator side cut to the recycle surge drum is governed by a liquid-level controller on the drum.

● **Acknowledgments.** The writer is indebted to D. L. Hooker, manager of Eastern and Foreign Refineries, H. W. Sheldon, Paulsboro refinery manager, and Daniel McCarthy, public relations—all of Socony-Vacuum Oil Company, Inc., for the many courtesies extended.

He gratefully acknowledges the assistance given by R. M. Chesney, general foreman, Socony-Vacuum Paulsboro Cracking Department, and Dr. E. R. Smoley, W. C. Dickerman, Jr., R. D. Underwood, and P. W. Thomen—all of The Lummus Company—in supplying the data from which this series of articles was written. He particularly thanks Stanley M. Mercier, chief engineer, Jeffrey Manufacturing Company, for permission to quote from his material on the subject of hot catalyst elevators. ★ ★ ★

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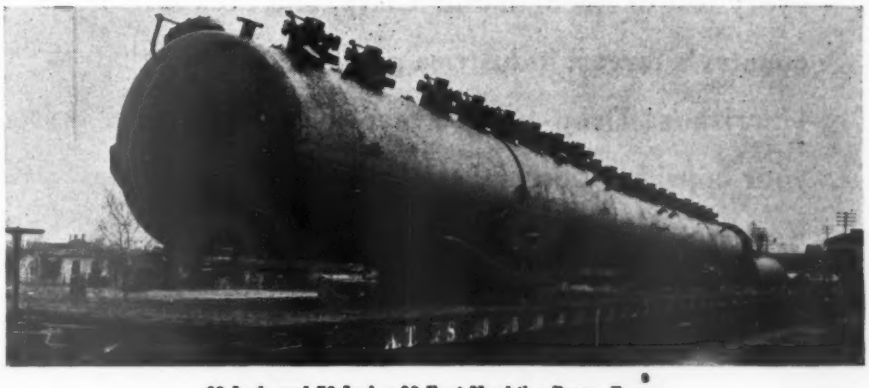

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Harrisburg, Pennsylvania

Manager of sales

Daniel A. Herrick has been appointed manager of sales of d'Este division of American Chain and Cable Company, Inc., with headquarters at Reading, Pennsylvania. Although this is a new division of the company, the d'Este line of automatic regulating valves, pressure reducing valves, tank and float valves has been made by the company for some time, and Herrick has been active in the sale of these products for several years.

Director of purchases

Young Radiator Company, Racine, Wisconsin, announces the appointment of J. A. Rumpsa as director of purchases. Rumpsa has had a wide background of practical experience in the field of purchasing. He completed an academic course at DePaul, Chicago. Later he accepted the position of assistant purchasing agent for the Illinois Malleable Iron Company of Chicago. From the Illinois Malleable Iron Company he moved to California to go into business for himself. In 1929 he joined the staff of the purchasing department of the Caterpillar Tractor Company. He was appointed director of purchases of the Young Radiator Company, April 15.

Dowell vice president

John G. Staudt, general manager of Dowell Incorporated, has been made a vice president of the company. Staudt, who holds degrees in chemical engineering from the University of Michigan, joined Dowell in 1932 at the time the company was formed. He held numerous field positions before moving to Tulsa in 1934. He became general manager of Dowell in 1942.

To new post

W. G. Wood,, purchasing agent, has resigned from the Continental Supply Company to become special representative in the Mid-Continent territory for the Champion Machine and Forging Company of Cleveland, Ohio, makers of Champion plain end couplings. Wood has been with Continental since 1916. and was made purchasing agent in 192(

R. E. F. Schmid, who succeeds W. G. Wood as purchasing agent, has been associated with Continental since 1919, and is well known throughout the oil country having worked as store manager and field salesman at several Mid-Continent points until 1935, when he was transferred to the Dallas home office.

Kelly to new post

The Industrial Engineering Company, manufacturer and applier of Somastic pipe coating, announces the appointment of Thomas F. P. "Pat" Kelly as technical service engineer. For the last 15 years he has been engaged in corrosion mitigation work, and has been active in the oil, gas, and water pipe line fields. Kelly will make his headquarters in Bartlesville, Oklahoma.

Export manager

G. P. Gregory, Jr.

Looking ahead to the day when wartime restrictions will permit resumption of its extensive export business, the George E. Failing Supply Company, Enid, Oklahoma, and Houston, Texas, manufacturers of portable drilling equipment, has announced the appointment of G. P. Gregory, Jr., as export manager.

An office has been established at 30 Rockefeller Plaza, New York City.

Davis succeeds Taylor

C. E. Davis, general manager of the manufacturing department of Shell Oil Company, Inc., New York, has been

C. E. Davis

J. F. M. Taylor

elected a vice president to succeed J. F. M. Taylor, vice president in charge of manufacturing, according to a recent announcement. Taylor, who resigned effective June 15, is returning to California in order to devote more time to his personal interests and some private oil industry consulting work.

Well-known throughout the industry, Davis has been active during the war years in a number of industry-government committees, including the aviation gasoline advisory committee of the Petroleum Administration for War, and is now serving as chairman of its catalytic cracking subcommittee.

Davis, a native of Oklahoma, received his early education there and in Missouri. He went to work for the Shell organization in 1917 as a shipping clerk in the company's refinery at Cushing, Oklahoma. In ensuing years he was advanced to other positions at the company's refineries at Wood River, Illinois, Arkansas City, Arkansas, East Chicago, Indiana, and Houston, Texas. In 1932 he was transferred to the company's main office at St. Louis in the operations section of the manufacturing department. The following year he became assistant to the manager of that department, and in 1938 assistant to the vice president in charge of manufacturing. In 1940 he was made manager of the manufacturing department, and in 1943 general manager of manufacturing. His home is at Ardsley-on-Hudson outside New York City.

Move Chicago office

Reflecting growth of its business in the Chicago area and confidence in the postwar future, Shand and Jurs Company, manufacturers of petroleum tank fittings, has moved its Chicago office from 310 South Michigan Boulevard to the Marshall Field Annex at 25 East Washington Street. The new telephone number is 1031. Robert Balke is the engineer in charge.

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New Rector plant at Fort Worth. *Inset:* View of a few of the production machines.

Rector expands

Rector Well Equipment Company's Fort Worth, Texas, headquarters announces an expansion program that has put the production of Rector casingheads and tubingheads at a far greater volume than at any time in the company's 14-year history. A modern, fireproof shop covering 15,000 sq. ft. of floor space on a 2½-acre site less than 2 miles from downtown Fort Worth is now completely outfitted with the latest machine tools for head manufacture, and for assembling and testing complete Christmas trees. A railroad spurline runs directly into the shop. Ample warehouse space is available for the housing and handling of large stocks.

The manufacture of Rectorheads is continuing in the Wichita Falls plant where once all the company's production was handled. Complete facilities for the assembly and testing of Rector Christmas trees have also been installed at the Wichita Falls location and at the Rector plant in Houston. With the expansion of manufacturing facilities, Rector Well Equipment Company has increased its field staff to beyond prewar size.

Ohio appointments

Several new appointments and changes in The Ohio Oil Company, Findlay, Ohio, have been announced by W. B. Emery, vice president and manager of production.

C. J. Hares, division geologist of the Casper division has been placed in charge of geologic research for foreign fields and foreign prospective oil and gas provinces.

R. W. McCanne has been appointed division geologist of the Casper division, succeeding Hares in that position.

F. R. Clark, division geologist of the Tulsa division, has been assigned to the handling of special problems involving geology and related matters in the Tulsa division.

R. A. Koenig, formerly division geologist and acting manager of the Findlay division, has been appointed division geologist of the Tulsa division.

R. L. Fillner, division landman for the Findlay division, has been appointed acting superintendent and division landman of the Findlay division, to assume all supervisory responsibilities in that division formerly carried by Koenig.

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2 Sizes — 1200 and 2000 Watts
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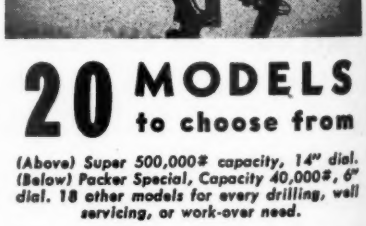

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Special leave for GIs

A special leave of absence will be granted to employes of The Texas Company who return from military service and who desire to take advantage of the Servicemen's Readjustment Act of 1944 (the G. I. Bill) to pursue studies that will benefit them in their future association with the company, it is announced by W. S. S. Rodgers, chairman of the board of directors. In addition, financial assistance in the form of loans without interest will be extended to these veterans in cases where the amount available under the law may be inadequate.

The leave is for one year, subject to extension at the end of each year, provided the employe is making satisfactory progress in his studies. The educational leave is available to any employe who had at least four months' service with Texaco before entering military service.

The employe's benefits under the company's group life insurance, pension, and hospitalization plans, will continue as though the employe were in active company service.

Upon the employe's return to company service, full consideration will be given to the knowledge and skill he acquired while on educational leave and to his accumulated seniority with the company, including the period of his leave. More than 5000 men and women of The Texas Company are on military leave of absence.

Cavins expands facilities

The Cavins Company, 2853 Cherry Avenue, Long Beach, California, announces the recent completion of a modern office building with enlarged service and manufacturing facilities. The Cavins suction bailer and other well cleaning products, as well as the new Cavins depthometer for wire line measurements, are manufactured at this address.

New service policy

Buckeye Traction Ditcher Company, Findlay, Ohio, has announced a new service policy for the Mid-Continent area. Instead of maintaining branch offices and stocks of parts in several key cities, as in the past, it is planned to have each Mid-Continent dealer eventually stock an adequate supply of parts for pipe line trenchers and other Buckeye equipment, so that operators can obtain "on-the-spot" service.

The first step in carrying out this plan is the elimination of Buckeye's Tulsa branch office and parts depot, as such. In the future, complete parts stock and greatly improved service facilities will be maintained by the Wylie-Stewart Machinery Company whose main office and warehouse is at 1400 Exchange Avenue, Oklahoma City, Oklahoma, the latest addition to the family of Buckeye dealers in the Mid-Continent field.

Officials of the Buckeye Traction Ditcher Company feel that the new setup will bring a definite improvement in service.

E. Franks promoted

Allis-Chalmers Manufacturing Company, Tractor Division, announces the appointment of Ernest Franks in charge of sales of industrial wheel tractors and power units with headquarters at Milwaukee, Wisconsin. Franks has been with the company since 1927. From that time until 1935, he was engaged in service and field engineering. His broad experience in the field qualifies him well to handle sales of industrial wheel tractors in addition to the power unit department, which he has headed for the last 10 years.

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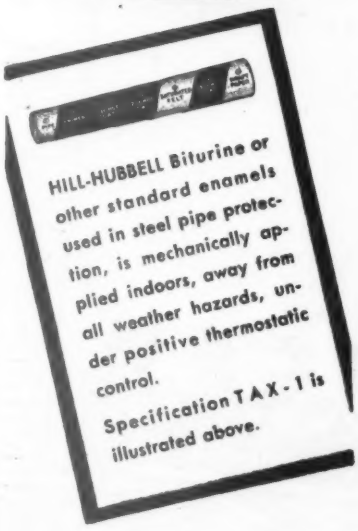
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Weyland promoted

A. H. Weyland, general superintendent of the Arkansas Natural Companies since 1933, was elected to the office of vice president and general manager, and director, of the Arkansas Louisiana Gas Company, Arkansas Natural Gas Corporation, Arkansas Fuel Oil Company, and Arkansas Pipeline Corporation, at a board meeting in New York City, the home office at Shreveport, Louisiana, announced. The resignations of D. W. Harris, former president, and B. R. Muirhead, former treasurer, of the Arkansas Natural Gas Corporation, were accepted by directors. Harris and Muirhead resigned to accept executive positions with another organization.

A. H. Weyland

Joining the Cities Service organization in 1919 after graduating from Texas A. and M. College, where he received a B.S. degree in electrical engineering, Weyland moves into his new office with 26 years' of well qualified experience in the oil business. He first became a part of the Cities Service family in Bartlesville, Oklahoma, when he accepted a position as junior engineer with the Empire Companies.

From 1919 through 1926 Weyland received a well-rounded education in the oil business while on assignments in the states of Arkansas, Texas, Kansas, and Oklahoma.

In 1925 he was transferred to El Dorado, Arkansas, and promoted to the position of district superintendent of the Natural Gas and Fuel Company, in charge of drilling. In 1926 he was moved to Tullos, Louisiana, as district superintendent in charge of drilling and production in the Urania field.

Weyland was promoted to the position of superintendent of oil production, Arkansas Natural Gas Company, in 1928 and transferred to Shreveport.

In 1933 he was again promoted and made general superintendent in charge of all operations of the Arkansas Natural and all associated subsidiaries; the Louisiana Oil Refining Corporation, Arkansas Louisiana Gas Company, Arkansas Fuel Oil Company, Arkansas Pipeline Company, and the Little Rock Gas and Fuel Company.

In 1936 Mr. Weyland was elected vice president of the Arkansas Louisiana Gas Company, a subsidiary of the Arkansas Natural Gas Corporation.

Two other promotions announced by the board included that of H. T. Goss, chief engineer of all Arkansas Natural Companies, who will assume the position formerly held by Weyland; and M. J. Lasseigne who was named treasurer of the Arkansas Natural Gas Corporation, Arkansas Louisiana Gas Co., replacing Muirhead.

Goss has been with the Cities Service organization for 23 years, and has acted in the responsible capacity of chief engineer since July, 1932.

Lasseigne started with the Empire Companies, Bartlesville, Oklahoma, in 1919 after graduating from Louisiana State University. He was named acting head of the financial department in February, 1944.

B. P. Sibole dies

Barton P. Sibole, 57, Tulsa, Oklahoma, president of the Stanolind Pipe Line Company, died June 6 of a heart ailment. He had been confined to his home and a hospital since January.

Sibole was one of Tulsa's leading civic figures. His interests were widespread and there was perhaps no one in the city of Tulsa who was more generally known and liked than he.

He went to Tulsa in 1920 as temporary assistant to S. C. Phillips, head of the Sinclair Oil and Gas Company motor transport department. When Standard Oil Company of Indiana acquired half ownership of the Sinclair Pipe Line Company in 1921, Sibole became assistant to John R. Manion, president of the latter firm. In 1930, Standard bought the other half of the Sinclair company, and Sibole was made vice president of the Stanolind Pipe Line Company, the name by which the Standard of Indiana's pipe line system was known. He was made president of Stanolind February 2, 1942, succeeding A. W. Peake, now president of the Standard Oil Company of Indiana.

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Bannan honored

Thomas J. Bannan, president of the Western Gear Works of Seattle and Los Angeles and its associate, the Pacific Gear and Tool Works of San Francisco, was recently elected vice-president of the American Gear Manufacturers' Association at its annual meeting at Hot Springs, Virginia.

In addition to his 25 years' service with these two Coast firms, Bannan is president of the Webster-Brinkley Company and the Hallidie Machine Company, both of Seattle, and is a member of the OPA advisory committee for the gear industry. He has been active in the affairs of the AGMA for many years and prior to his election was a member of the association's executive committee.

Kobe division manager

Kobe, Incorporated, a member of Dresser Industries, has announced the appointment of Ross J. Lyons as California division manager to fill the vacancy occasioned by the recent advancement of W. F. Slater to the new position of manager of technical service. Lyons will make his headquarters in the company's California division offices in the Wilson Building, Huntington Park.

Ross J. Lyons

After attending the engineering school of Oklahoma University and doing varied field work with producing companies, Lyons became associated with the U. S. Engineers in Saint Louis as an inspector and hydrographer. In 1936 he returned to the oil industry and became interested in pumping equipment and for several years was actively engaged in field and technical studies of pumping operations. Lyons joined Kobe in 1941 at Oklahoma City and was later appointed district manager of the company's operations in the North Texas area, which position he had filled until his recent move to California.

Key Company promotions

M. E. Burkhart

B. J. Gross

Key Company, East St. Louis, Illinois, announces the appointment of M. E. Burkhart as vice president in charge of sales, to replace B. J. Gross, who was transferred to the company's eastern office, 420 Lexington Avenue, New York City, on May 1.

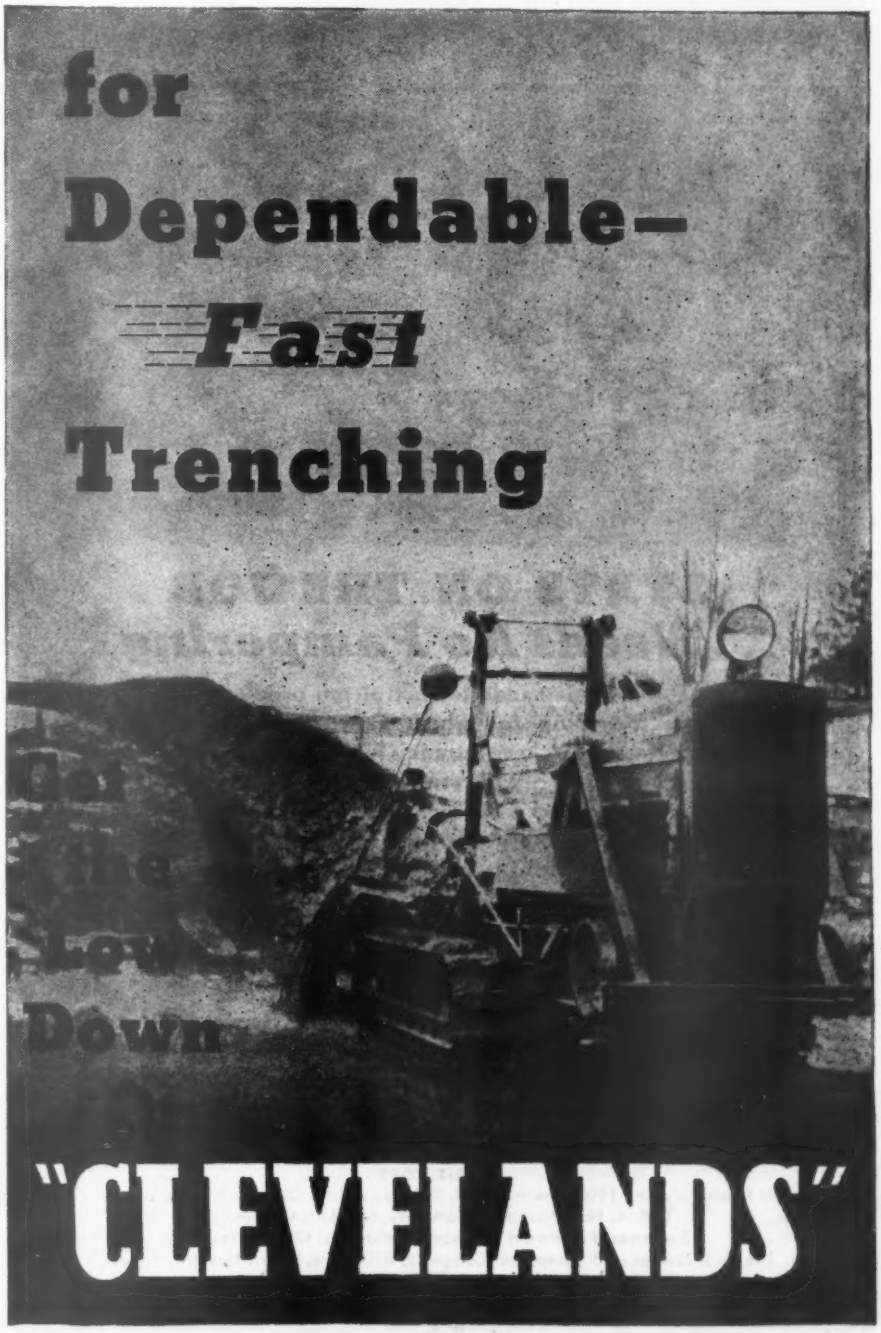
Burkhart has been with the company 18 years and was appointed chief engineer on the death of Dr. Fred Key in 1939. Gross has been with the company 12 years and was manager of sales for the last 5 years. He will be associated in the New York office with G. C. Smith, who has been with the company more than 20 years. The change is intended to provide better consulting service for the oil refining industry in the eastern district.

Expand facilities

Expansion of plant facilities and consolidation of sales offices were accomplished recently by Rucker-Vaughn Company in its Oakland location at 4228 Hollis Street. The company manufactures the Vaughn line of pressure regulating valves and gas and oil burning equipment, as well as the Arnold lubricator, an air tool specialty.

According to Clark E. Rucker, who is in charge of sales, the company has stepped up its production capacity, both through plant expansion and improved production methods. The new developments include an improved service department for the complete rebuilding of used valves, and full valve maintenance service. Production is headed up by Clifford Vaughn.

The company also is distributor for a number of production tool lines.



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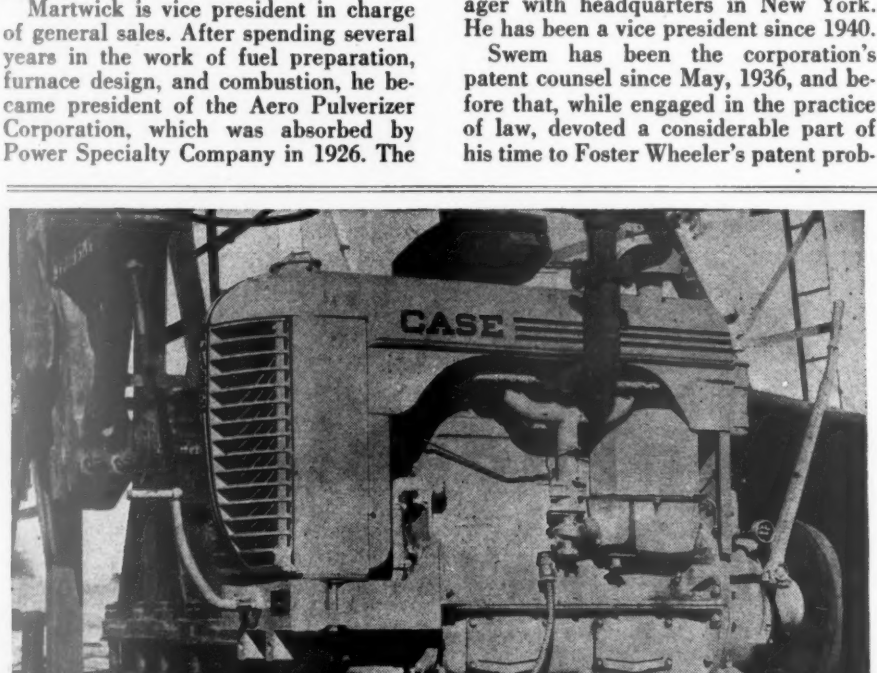
New directors

The election of William L. Martwick, Lee A. Swem, and Charles E. McCulloch as directors of Foster Wheeler Corporation was announced by J. J. Brown, chairman of the board. Each of the new directors has been associated with the corporation for several years and is well known throughout the industry.

Martwick is vice president in charge of general sales. After spending several years in the work of fuel preparation, furnace design, and combustion, he became president of the Aero Pulverizer Corporation, which was absorbed by Power Specialty Company in 1926. The latter company then organized a pulverizer and furnace division with Martwick as manager, an arrangement that was continued after Power Specialty was succeeded the following year by the Foster Wheeler Corporation. In 1932 Martwick went to Chicago as director of Foster Wheeler's western offices and 5 years later was appointed general sales manager with headquarters in New York. He has been a vice president since 1940.

Swem has been the corporation's patent counsel since May, 1936, and before that, while engaged in the practice of law, devoted a considerable part of his time to Foster Wheeler's patent problems. A native of Washington, D. C., he graduated from Georgetown University Law School in 1926 after first studying mechanical engineering at George Washington University and the Massachusetts Institute of Technology. He became an examiner in the U. S. Patent Office and then was associated with William G. McKnight in the practice of law in New York City. When McKnight, who was Foster Wheeler's patent attorney, retired, Swem succeeded him.

Manager of Foster Wheeler's petroleum refinery division for the last 8 years, McCulloch has had a wide experience in the field of chemical engineering. After graduating from Massachusetts Institute of Technology in 1926, he joined the National Carbon Division of the Union Carbide and Carbon Corporation as an analytical chemist and later became chemical engineer for the Tidewater Oil Company. He joined Foster Wheeler's refinery division in 1927 and 10 years later was appointed manager of the department, in which position he has gathered together a corps of outstanding experts in the many phases of this complicated work.



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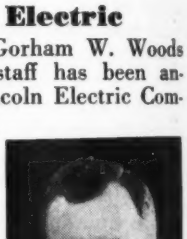
The Gulf Tractor and Equipment Company, 3100 Polk Street, Houston, Texas

CASE KEEP ON BUYING WAR BONDS

Joins Lincoln Electric

The addition of Gorham W. Woods to its engineering staff has been announced by The Lincoln Electric Company, Cleveland, Ohio.



G. W. Woods

Joining the company as research engineer, Woods will devote a major part of his time to the development of electrodes, a post for which he is well qualified in view of his many years' experience in the field of chemistry and metallurgy.

A graduate of Rice Institute of Houston, Texas, he received his B.S. degree in chemical engineering in 1923.

Woods was chief chemist of the Hughes Tool Company, of Houston for 7 years, and development engineer of the same firm for 12 years. His duties included the design, manufacture, and use of oil field tools and supervision of work in various steel mills and oil fields in the southwest and Mexico.

During the last 3 years he was process engineer of the Dickson Gun Plant, a Hughes-operated concern, where he had charge of the technical aspects involved in the manufacture of cannon by the centrifugal casting process.

A registered professional engineer in the states of Texas and Ohio, Mr. Woods is a member of the American Welding Society and in 1940-41 was chairman of the South Texas Section. He has done considerable research and experimental work in the development of welding electrodes, materials, and processes. He is also a member of the American Society for Metals and Tau Beta Phi fraternity.

Export representative

Appointment of H. Lester Freeman as Washington representative for the export division of the Oil Well Supply Company, U.S. Steel subsidiary, was announced by Fred F. Murray, company president, Dallas, Texas.

H. L. Freeman

Freeman, during the current war, has filled several important posts in the Petroleum Administration for War, including that of executive secretary of the foreign petroleum materials committee and executive secretary of the foreign operating committee.

Freeman has a background of long experience in the foreign oil industry. He was employed by the Soc. Romano-Americana in Rumania from 1926 until the summer of 1941. He served in various capacities with this foreign subsidiary of the Standard Oil Company of New Jersey, becoming assistant purchasing agent in 1930. In 1935 the Standard Oil Company sent him to London as assistant to the European manager of the Foreign Production Department. In 1937 Freeman returned to Rumania as assistant to the manager of the Romano-Americana's production department.

Returning to the United States in 1941, he assisted in the organization of the Portland Pipe Line Company. In 1942 he joined the PAW staff as materials specialist.

Engineering service

A new type of service available to the petroleum industry has been organized under the name of John P. Squier. The address is Box 6100, Dallas, Texas. A feature of this new organization is precision computing of orifice meter charts by the use of Emco-McGaughy integrators. All work is done under the supervision of gas measurement experts and engineers, and smaller operators may now obtain these advantages through this source, it is announced. The rapid service available on chart computations will form a convenient service to the larger companies in the event of equipment emergencies or labor shortages, it is pointed out.

Geologist speaks

Stating that Lower California is a strip of territory as long as the State of California itself and that it has been relatively unexplored geologically in comparison to its northern neighbor, Carl H. Beal, Los Angeles consulting geologist, addressed the Pacific Section of the American Association of Petroleum Geologists at a luncheon held at the University Club on Friday, May 25.

Beal's subject was "A Reconnaissance of the Geology and Oil Possibilities of Baja California."

Up to the time a party of geologists of which Beal was a member spent 18 months in exploring Lower California in 1921 and 1922 very little work had been done in the area by geologists. Due to the inaccessibility of the country not much work has been done on a large scale even today. "There are lots of problems to be worked out by future geologists," continued Beal.

Beal stated that two areas, both in the west central part of Lower California, should be further explored for the possibilities of oil, although no encouraging indications of oil, such as oil seepages, could be found in these regions.

The speaker considered that the area comprising Lower California is part of a great rectangular block bounded on the east by a deep trough which is the Gulf of California, and drew some interesting analogies between the mountains of the northern part of Lower California with the Santa Ana Mountains near Los Angeles.

Beal divided up the territory in general into three divisions, a northern part consisting of mountains rising to an elevation of 10,000 ft., a central area consisting of some mountains and a desert region, and a southern part which culminates in a low isthmus with many granite ridges. "Granites occupy nearly one-half of the area of Baja California," he said.

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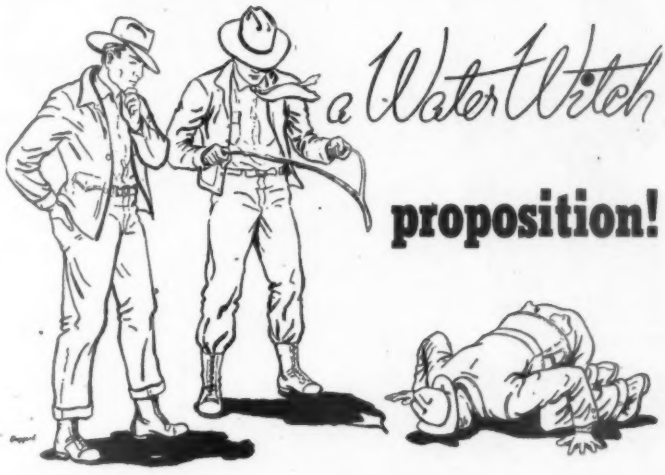

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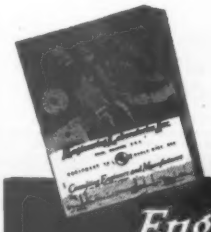

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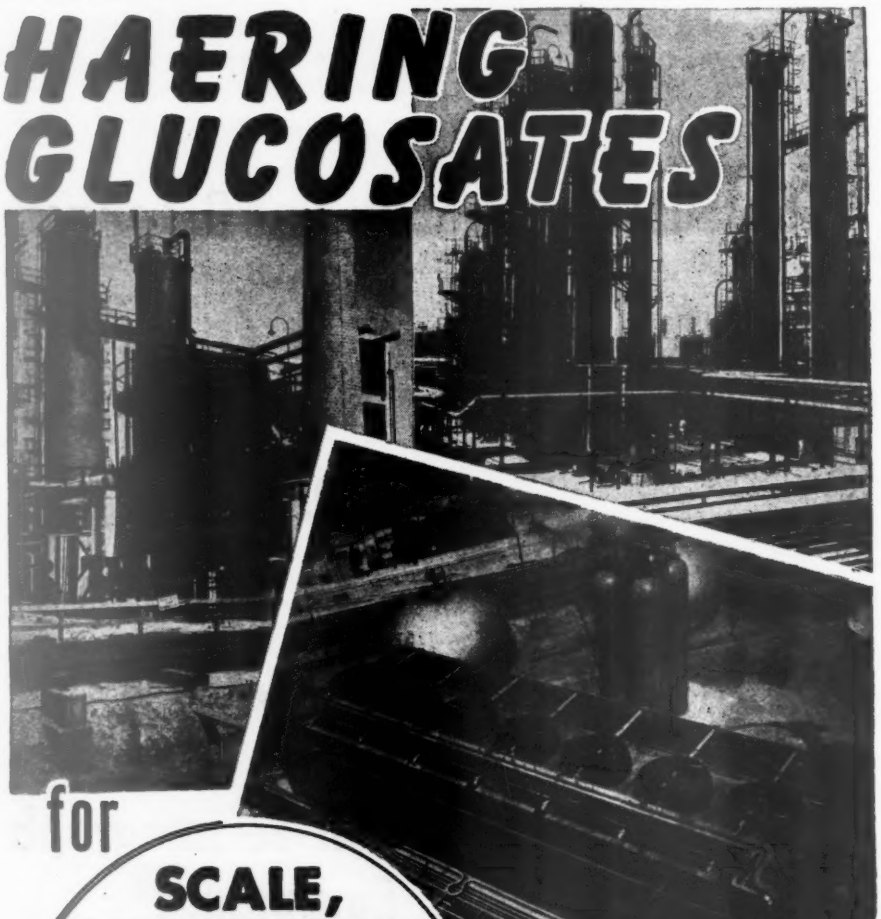

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AIME chapter officers

Officers of the new North Texas Section of the AIME elected at the first meeting held May 31 in Dallas, Texas, and distinguished guests are: Richard T. Bright, Mercantile National Bank, Dallas, secretary-treasurer; Charles H. Pishney, Cummings, Berger, and Pishney, Fort Worth, chairman; E. DeGolyer, DeGolyer and MacNaughton, Dallas, past president and director of the AIME; Brad Mills, executive secretary American Association of Oilwell Drilling Contractors, Dallas, vice-chairman; W. S. Morris, vice president-general manager, East Texas Salt Water Disposal Co., Kilgore, past chairman Petroleum Division and member executive committee of AIME; P. P. Gregory, Yates Pool Engineering Committee, Fort Worth, director; Gordon Fisher, Gulf Oil Company, Fort Worth, vice-chairman, and K. Bruce Davidson, Humble Oil and Refining Company, Wichita Falls, vice-chairman. Directors elected but not shown are T. K. Knox, Republic Natural Gas Company, Dallas; George Card, Stanolind Oil and Gas Company, Fort Worth; and V. C. Perini, Jr., geologist and oil operator, Abilene, and Barney Fisher, Los Tecas Petroleum Company, Dallas.

Regular monthly meetings will be held alternately in Fort Worth and Dallas beginning next September. Members of the East Texas section who live in Dallas have been released to permit their affiliation with the North Texas section. The new section was created by order of the board of directors on May 16 at a meeting in New York. Charles B. Carpenter, U. S. Bureau of Mines, Dallas; Warren J. Jackson, Lane-Wells Company, Dallas; R. S. McFarland, Seaboard Oil Company, Dallas; Lynn K. Lee, Pure Oil Company, Fort Worth, and L. F. Peterson, Stanolind Oil and Gas Company, Fort Worth, served as the nominating committee and drafted by-laws for the North Texas Section.

New sales managers

As a step in current plans to effect better service to the industry and to meet the expanding requirements for hydraulic pumping equipment, Kobe, Incorporated, a member of Dresser Industries, has just announced the appointment of two sales management positions in the company's Mid-Continent Division.

R. A. Feemster in the future will make his headquarters in Dallas and coordinate the activities of the company's

southern districts including the Gulf Coast, East Texas, West Texas, and North Texas. The sales management of the company's northern districts covering Oklahoma, Kansas, Wyoming, Nebraska, and Illinois in the future will be under the direction of M. L. Walraven, Jr., who will continue his headquarters in the company's Tulsa offices. Both of these activities will remain under the direction of R. G. Ralph, division manager in Oklahoma City.

R. A. Feemster

M. L. Walraven, Jr.

After graduating from the School of Petroleum Engineering at Oklahoma University in 1932, Feemster for several years was associated with the engineering and production department of a major oil company. In 1941 he joined Kobe as district representative in Oklahoma City and was later appointed Mid-Continent division sales manager, which position he has filled until his recent move to Dallas.

Walraven, after specialized work in the machine tool and engineering design field of both the aircraft and oil producing equipment industries, joined the Kobe organization in California during 1933. He was later associated with the company's early work in the Oklahoma City field and in 1940 was appointed district manager in charge of the company's Kansas activities. In 1942 Walraven was advanced to the district managership of the Tulsa office, which position he has filled until his recent promotion.

Textbook award program

A 12-page brochure, covering the object and purpose of the award program for textbooks in modern design and setting forth all rules and conditions governing the program, has been published by trustees of The James F. Lincoln Arc Welding Foundation, Cleveland, Ohio.

The brochure is the official document of the new award program as announced by the foundation in April to encourage preparation of textbooks on design for use of engineering undergraduates in machine design and in structural design for fabrication by all processes including welding. It covers thoroughly the types of subject matter to be treated in these two important fields, listing the awards, which are divided into the two classes and which total $20,000.

The brochure, entitled, "$20,000 Award Program for Textbooks Covering Machine and Structural Design for Modern Processes Including Welding," may be obtained gratis by anyone interested. Requests should be addressed, Secretary, The James F. Lincoln Arc Welding Foundation, Cleveland 1, Ohio.

To S. A. posts

The appointment of Patrick W. Cross as manager of the Sao Paulo office of Westinghouse Company of Brazil and the appointment of W. W. Parker as regional engineer in the Rio de Janeiro office of Westinghouse have been announced by the Westinghouse International Company.

Cross, who is a graduate of the Virginia Polytechnic Institute, entered the Westinghouse student course in 1934 after a year with the Newport News Shipbuilding and Drydock Company. In 1936 he went in the transportation division of the Philadelphia district office. In 1939 Cross transferred to the distributor sales department of the Westinghouse International Company where he remained until 1941 when he went to Venezuela for C. A. Armco Venezolana, the Westinghouse distributor for the petroleum industry. In his present position he will serve as regional engineer of the Sao Paulo area as well as manager of the Sao Paulo office.

Parker joined Westinghouse as a member of the student engineering course upon his graduation from Yale Sheffield Scientific School in 1927 and was transferred to the switchgear division the following year. In his new position, as regional engineer, he will render technical assistance to Westinghouse distributors and customers.

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THIS J-M machine double-coats and double-wraps pipe lines—gives dual protection in one cost-saving operation.

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For full details on how the J-M Coating and Wrapping Machine and J-M Asbestos Pipe Line Felts can guard your own lines against corrosion—and save you time and money in your pipe-wrapping operation—write Johns-Manville, 22 East 40th Street, New York 16, N. Y.

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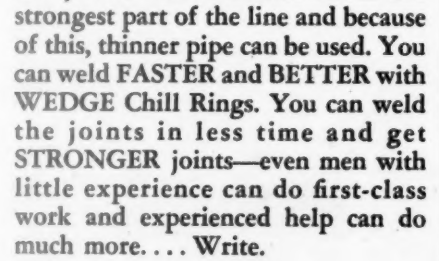

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Hapke joins API staff

Al Hapke, Jr., has joined the staff of the American Petroleum Industries Committee of the American Petroleum Institute, 50 West 50th Street, New York, to head its newly created aviation section, it was announced today by B. H. Markham, the committee's director. The new section will concern itself with problems relating to taxation, the financing of aircraft landing facilities, and related matters.

Prior to joining the committee's staff, Hapke was market research manager for Republic Aviation Corporation and in this capacity participated actively in the work of the various aviation trade associations.

Instrument society formed

A new national society to be known as The Instrument Society of America was organized in Pittsburgh at a conference attended by delegates from 15 measurement and control instrument societies that have been growing in different industrial centers throughout the country.

The purpose of the Society will be to advance the arts and sciences that are connected with the theory, design, manufacture, and use of instruments. The society is non-professional, and offers membership to any person, firm, or institution interested in its objectives.

Pro-tem officers were elected as follows: President, A. F. Sperry, Chicago; vice president, C. F. Kayan, New York; treasurer, C. E. Fry, Pittsburgh; and secretary, Richard Rimbach, Pittsburgh.

Various committees also were appointed to proceed with organization work and preparation of constitution and by-laws.

The office of the secretary is the temporary office of the Society and is at 1117 Wolfendale Street, Pittsburgh 12, Pennsylvania.

DeGolyer bank director

Everette Lee DeGolyer, geologist of Dallas, Texas, has been elected a director of Empire Trust Company, New York, according to an announcement by Henry C. Brunie, president. DeGolyer is a partner in the firm of DeGolyer and MacNaughton, and a director of Transwestern Oil Corporation, First National Bank of Dallas, Texas, and Louisiana Land and Exploration Company.

DeGolyer is a graduate of the University of Oklahoma and an honorary Doctor of Science of Colorado School of Mines. He was formerly chief geologist of Mexican Eagle Oil Company and chairman of the board and general manager of Amerada Corporation. He is a member of various American and international scientific and engineering societies, and a director of American Petroleum Institute. DeGolyer was awarded the John Fritz medal in January, 1942, by the Institute of Mining and Metallurgical Engineers.

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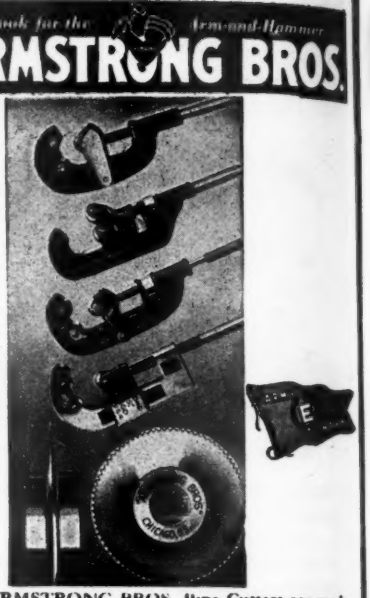

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Heads gas association

Louis C. Smith, president of the Harrisburg Gas Company since 1935, was elected president of the Pennsylvania Gas Association at the 37th annual meeting held in Philadelphia. He succeeds Charles K. Steinmetz, Pennsylvania Power and Light Company, of Carlisle, Pennsylvania.

Smith was graduated from the University of Pennsylvania in mechanical engineering in 1907 and joined the United Gas Improvement Company May 18, 1908, in Philadelphia. He has been associated with the Omaha Gas Company, was president of the Fulton County Gas and Electric Company, and vice president of New York Power and Light Corporation. He served as assistant managing director of the American Gas Association.

Society elects

At its last meeting the Shreveport Geological Society elected new officers for 1945-1946.

The new president is T. H. Philpott of the Carter Oil Company. Vice president is Van D. Robinson of the Atlantic Refining Company, and the new secretary-treasurer is W. E. Wallace of the Sohio Corporation.

Although no meetings will be held until the fall, the Society will be busy this summer completing and publishing its forthcoming publication, "The Important Oil and Gas Fields in North Louisiana, South Arkansas, Mississippi, and Alabama," which will be issued on or about August 1.

Anderson promoted

C. C. Anderson, engineer-in-charge of the U. S. Bureau of Mines, Exell, Texas, helium plant since its opening in March. 1939, has been appointed assistant chief of the Petroleum and Natural Gas Division in Washington, D. C., Dr. R. R. Sayers, Bureau Director announces.

Anderson, who supervised the construction of the Exell plant, largest of the five helium plants operated by the Bureau, replaces H. C. Fowler, recently named supervising engineer of the Bureau's Petroleum Experiment Station at Bartlesville, Oklahoma.

The new assistant to R. A. Cattell, chief of the Petroleum and Natural Gas Division, which supervises helium production activities, has been with the Bureau for 21 years, joining the staff in Washington as assistant chemist in May, 1924. Two years later he was transferred to the Fort Worth, Texas, Helium Plant and since that time has been closely identified with the expansion of the Bureau's helium production facilities, both in peacetime and in war time.

California officials elected

The Conservation Committee of California Oil Producers met on May 29, 1945, at which time the new committee was organized and officers elected for the ensuing year.

Joseph Jensen, of the Tide Water Associated Oil Company, was named chair-

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Where there's a power job to be done, or a piece of equipment to be operated . . . time-, labor- and maintenance costs to be saved . . . Wisconsin Heavy-Duty Air-Cooled Engines can be depended upon to *come through* and keep on coming back for more.

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Oil field distributors for Wisconsin Engines and all types of utility units.

man of the Conservation Committee of California Oil Producers. He succeeds John B. Sutherland of The Ohio Oil Company. H. S. Stark, Honolulu Oil Corporation, was elected first vice chairman; John Hancock, The Hancock Oil Company of California, second vice chairman, and Carlton Beal, Richfield Oil Corporation, secretary.

The committee is made up of chairmen and vice chairmen of district committees, elected by producers of the 27 oil producing districts into which the state is divided.

District committee chairmen and vice chairmen who constitute the membership of the conservation committee are:

District No. 1, Max S. App, chairman; R. C. Patterson, vice chairman; District No. 2, H. S. Stark, chairman, W. A. Clark, vice chairman; District No. 3, John B. Sutherland, chairman, Carlton Beal, vice chairman; District No. 4, W. S. Fisher, chairman, Ray Earle, vice chairman; District No. 5, Robert S. Lytle, chairman, R. A. Holman, vice chairman; District No. 6, J. H. Sargent, chairman, E. J. Young, vice chairman; District No. 7, R. J. Stephens, chairman, C. W. Stephens, vice chairman; District No. 8, R. P. Huggins, chairman, Charles Prewett, vice chairman; District No. 9, E. L. Smith, chairman, H. W. Abruns, vice chairman; District No. 10, J. L. Stephens, chairman, Claude Pearson, vice chairman; District No. 11, Robert M. Allan, Jr., chairman, G. T. Pearson, vice chairman; District No. 12, Guy H. Cherry, Jr., chairman, John Hancock, vice chairman; District No. 13, Basil P. Kantzer, chairman, D. A. Cushman, vice chairman; District No. 14, L. E. Porter, chairman, T. H. Rodgers, vice chairman; District No. 15, Joseph Jensen, chairman, O. I. Torkelsen, vice chairman; District No. 16, D. L. Caldwell, chairman, Lot Bowen, vice chairman; District No. 17, A. H. Bell, chairman, Warren Craddock, vice chairman; District No. 18, Pat Henderson, chairman, H. A. Brett, vice chairman; District No. 19, Wm. L. Hobro, chairman, Dean H. Sheldon, vice chairman; District No. 20, E. Robert Burns, chairman, Laurence C. Kelly, vice chairman; District No. 21, D. K. Weaver, chairman, T. H. Sherman, vice chairman; District No. 22, Warner Clark, chairman, Quay S. Diven, vice chairman; District No. 23, D. W. Elliott, chairman, Chester F. Yunker, vice chairman; District No. 24, R. H. Garrison, chairman, C. M. Rood, vice chairman; District No. 25, Emil Kluth, chairman, Henry F. Power, vice chairman; District No. 26, Russell H. Green, chairman, E. J. Bartosh, vice chairman; District No. 27, Chester F. Dolley, chairman, O. M. Slosson, vice chairman.

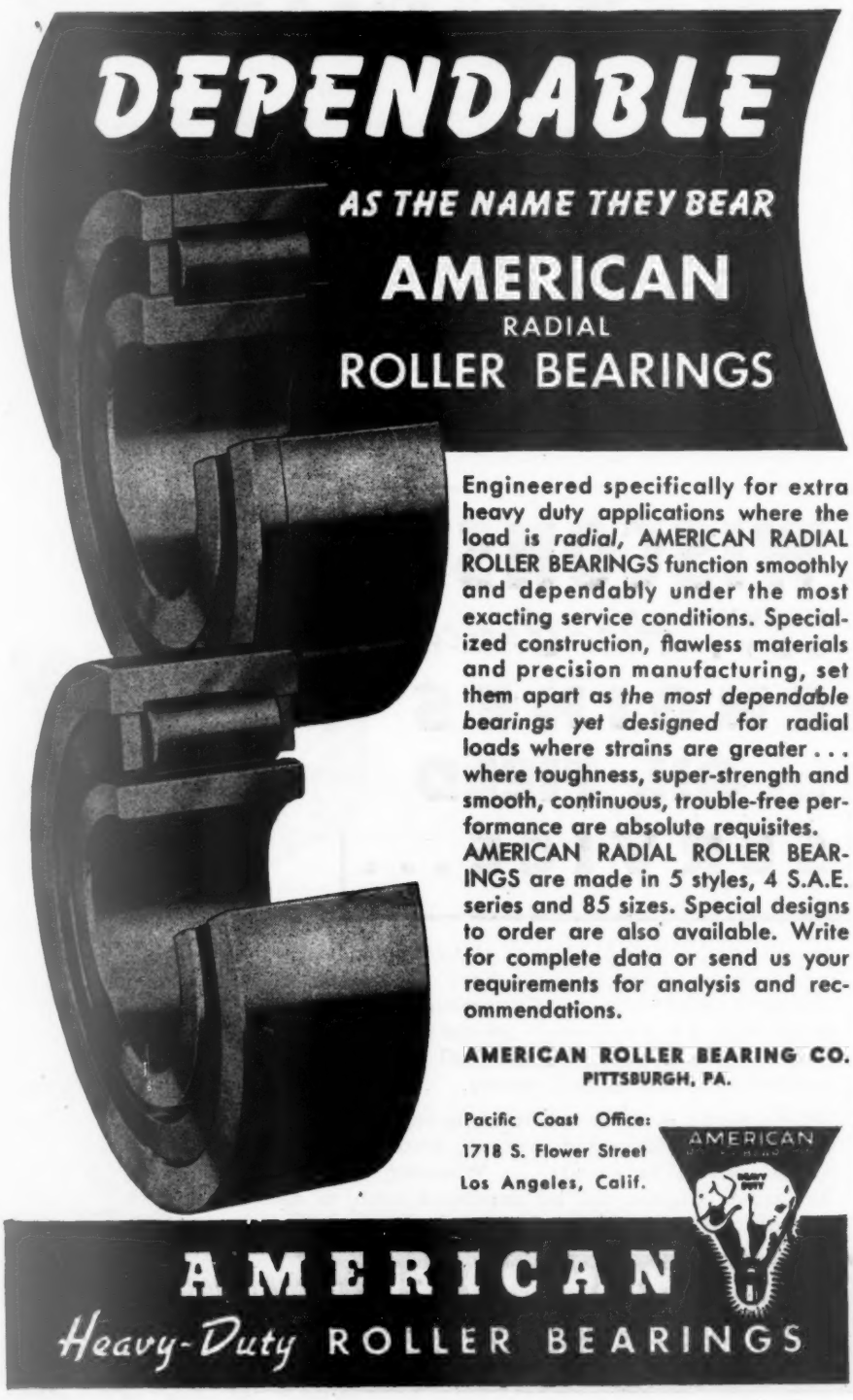
Leaves rubber reserve

On June 4, the associates in Rubber Reserve Company of Rufus L. Savage honored him on the occasion of his return to private industry with a farewell dinner at the Hotel Statler.

Since early 1942, Savage, one of the first chemical engineers to join Rubber Reserve Company, the Reconstruction Finance Corporation subsidiary in charge of government rubber, has assisted in setting up the synthetic rubber program and in the development and supervision of technical and production organizations in this government owned corporation.

Savage, at his departure, was production manager of butadiene from petroleum.

A graduate of Lehigh University in 1931, Savage, prior to his assignment in Washington, was a resident of Scarsdale, New York, and as a petroleum refining development engineer, had been in the service of The Texas Company for 11 years in Port Arthur, Texas, and New York City. He now returns to New York where he will be associated with the Texaco Development Corporation.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Twin Crank, Skid Type, O.C.S. 30 hp. Bat Pumping Unit complete. Ser. No. 8469. P. R. load 20,000 lb. Powered by 40 hp. 7½ in. by 9 in. Clark 2-cycle vertical twin pumping engine (Bobcat), R. B. crank shaft, clutch and 16-in. S. C. Grove Engine Sheave, Driftmeter cooler for circulating system, O. C. S. Type No. 1 Bell crank underpull, and Marion jack. This two-well hook-up is in A-1 condition and now operating in Gladewater. Will sell for 60 per cent of new price.

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Kobe general technical service

Kobe, Incorporated, one of the Dresser Industries, has announced the establishment of a general technical service department under the direction of W. F. Slater who will be in charge of all the company's technical field activities.

W. F. Slater

This new agency has been established to meet the expanding interest in hydraulic oil well pumping and to effect an improved service on oil well pumping problems, company officials announced. The company's Mid-Continent division technical activities will continue to be headed up by H. K. Ihrig, whereas the California division technical work will be carried on by R. L. Fanthus.

Slater brings to his new position a broad experience in oil well pumping problems. After leaving the engineering schools of Oklahoma and Tulsa universities, he entered the oil production business and in 1936 was actively engaged in engineering and production studies of pumping equipment problems, doing work both in California and Mid-Continent oil fields. In 1941 he became associated with Kobe, Incorporated as Tulsa district manager and in May, 1942, was appointed California division manager, which position he has held until his new appointment.

Oechsle in charge of sales

Carl F. Oechsle has been appointed vice president in charge of sales of Ransome Machinery Company of Dunellen, New Jersey, a subsidiary of Worthington Pump and Machinery Corporation. The sale of Ransome's line of contractors' mixers and pavers will now be handled through Worthington's construction equipment department, of which Oechsle is manager. Headquarters of this sales department still remains in Holyoke, Massachusetts, with regional offices in New York, Washington, Cleveland, Chicago, and San Francisco.

C. F. Oechsle

Franks' new sales manager

Franks Manufacturing Corporation, Tulsa, Oklahoma, announces the elevation of R. E. Kirberger, assistant sales manager for the past year, to the post of sales manager.

Kirberger has been with Franks for the last 13 years, beginning as a machinist. He then served as a field service man for a number of years, going from there into the production department at the start of the war production program.

Kirberger's elevation to the post of sales manager is in line with the company policy, initiated by Carl White, Jr., president, of promotion within the organization.

Kirberger was born in Sistersville, West Virginia, one of the first oil towns in the country.

Christens ship

Mrs. Milo E. Smith was designated by Rear Admiral Arthur S. Carpender, USN, Commandant of the Ninth Naval District, as sponsor of the U. S. S. KRISHNA and christened the ship in launching ceremonies on May 25, 1945, at the Navy shipyard operated by the Chicago Bridge and Iron Company at Seneca, Illinois.

Mrs. Smith's husband, who is advertising manager of the Chicago Bridge and Iron Company, served for a year when the shipyard was built in 1942 as the company's representative to cooperate with various federal agencies in the establishment of off-site facilities such as housing, schools, water system, roads, etc., to serve the shipyard.

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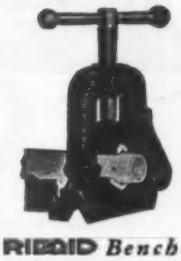
● An integral support that holds pipe firmly for easier cutting or threading — a handy efficient pipe bender — these added features for easier work make the RIDGID Bench Chain Vise a buy you'll long enjoy. It's speedy to use for any pipe to 8". Solidly gripping jaws are highest quality tool-steel, hardened for long wear. Comes in 5 sizes. Line includes also chain vises in post, stand and Tristand models. At your Supply House. We're doing our best to supply everybody.



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Magnesium Anodes for Cathodic Protection

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PUMP
Engineered to fit your well
For economy water pumping

A good water well is an asset worth many times its cost. But a well is no better than its pump. By installing a Peerless Turbine Pump you get the fullest value from your well because the pump is engineered to *fit your well.*

Capacities—10 to 220,000 gallons per minute.

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To handle Staynew filters

Fred Thilenius, well-known Tulsa equipment dealer, announces that his company has been selected to represent the complete line of Staynew Filters for air, gases, and liquids manufactured by Dollinger Corporation of Rochester, New York. Representation includes the entire state of Oklahoma.

Heads new export company

Lloyd G. Ensign, formerly general manager of Lee C. Moore and Company, Inc., Eastern Division, Pittsburgh, Pennsylvania, recently resigned to become president of Oilfield-Industrial Export, Inc., a company organized to engage in sales and service for the foreign market, specializing in oilfield and industrial equipment.

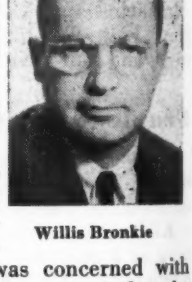
Lloyd G. Ensign

Ensign has been closely identified with the petroleum industry for the last 24 years, 15 of which were spent in charge of oil-producing operations in South America and the West Indies. Another 6 years were devoted to oilfield equipment sales in export, and for the last 2 years he has engaged in the direction of operations and sales for Lee C. Moore and Company, Inc., Eastern Division.

The new company has opened offices at Suite 5136 R.C.A. Building, 30 Rockefeller Plaza, New York 20, New York.

Named to staff

The Victaulic Company of America has announced the appointment of Willis Bronkie to the engineering and sales staff of that organization.



Willis Bronkie

A graduate of Yale University School of Engineering, 1933, Mr. Bronkie began his career with the Anaconda Copper Mining Company in Chile, South America, as assistant mine foreman. After his work with Anaconda, he went to Canada, where he was employed by the International Nickel Company of Canada, later becoming associated with the National Lead Company at Tahawus, New York, in the capacity of mine superintendent.

The Ingersoll-Rand Company was his next employer before entering government service with foreign economic administration in Brazil as superintendent of equipment and maintenance. This last work was concerned with obtaining quartz crystals, mica, and other elements vital to the war effort.

Bronkie will make his headquarters in the main office of the Victaulic Company of America, 30 Rockefeller Plaza, New York City.

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For . . . STEEL PLATE LINING • STEEL ENCASEMENT • BUILDING WALLS, ROOFS, FACINGS • TUNNEL LINING • WATER RESERVOIR LINING • POWER PLANTS—BUNKER LINING • SEWER REPAIRS • TANK LINING • CANAL AND DITCH LINING REPAIR OF DISINTEGRATED CONCRETE, BRICK, TILE, MASONRY.

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Heads Houdry department

Robert B. Cragin, vice president in charge of commercial development of Houdry Process Corporation, Wilmington, Delaware, has announced the appointment of a well-known petroleum engineer, Henry D. Noll, who has become manager of the project analysis department for Houdry.

H. D. Noll

Noll brings with him nearly 20 years' experience in plant operation, technical service, and petroleum research and development. For 19 years he was employed by Socony-Vacuum Oil Company, Inc., during which period he worked for Magnolia Petroleum Company at Beaumont, Texas, for 9 years. After his experience at Beaumont, Noll was transferred to the research and development laboratories of Socony-Vacuum at Paulsboro for several years of intensive work. Just prior to coming to Houdry, he was in New York with the manufacturing department of Socony-Vacuum on special wartime assignments.

He is a member of the Catalytic Cracking Subcommittee of the Aviation Gasoline Advisory Committee. Noll was born in Brooklyn and is a graduate of the University of Pittsburgh with a degree of petroleum engineer.

Hewitt vice president

Hewitt Rubber Corporation, Buffalo, New York, recently announced that Joseph H. Hayden has been promoted to the position of vice president and William H. Watkins has been named controller and assistant treasurer.

Hayden is widely known in the rubber industry, having been associated with Hewitt for 27 years. He is chairman of the mechanical rubber goods division of the rubber industry and is a member of the industry's committee to both the WPB and OPA. During the critical rubber crisis in 1942 he served as a consultant to the WPB in Washington.

Born and educated in Chicago, Hayden joined Hewitt immediately after service in the first World War. He became manager of the company's New York office in 1925, later returned to the Buffalo headquarters and was named secretary of the corporation in 1936. In assuming his new position of vice president, he retains the title and duties of secretary.

Watkins this year will complete his twentieth year of service with Hewitt. A native of Buffalo, he began his business career as a cost accountant with a Buffalo chemical firm. At Hewitt he has served as a cost specialist and has engaged in market research and analysis. He is one of the founders of the Buffalo chapter, Controller Institute of America. Until his recent promotion he was head of the Hewitt accounting department.

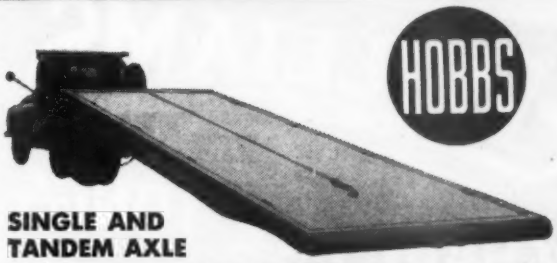
Division director

F. D. Newbury, vice president of the Westinghouse Electric Corporation, has announced the appointment of Frank W. Godsey, Jr., as manager of the new products division.

Godsey replaces G. H. Woodard, who has been transferred to South Philadelphia as manager of the corporation's aviation gas turbine division. His headquarters will be at the Pittsburgh, Pennsylvania, office.

Godsey was born at Beaumont, Texas, in 1906. He attended Rice Institute where he received a bachelor of science degree in engineering, then continued his studies at Yale University, where he received a master's degree. From 1928 until 1934 he was development engineer with the Safety Car Heating and Lighting Company, of New Haven, Connecticut, and for the next 6 years was chief electrical engineer and assistant production manager for the Sprague Electric Company, of North Adams, Massachusetts.

Since joining Westinghouse in 1940, Godsey has served in the division he now directs. Patents have been granted on some 40 electrical and mechanical devices invented by the new manager.



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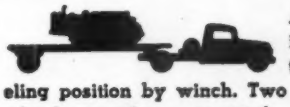
SELF-LOADING FLOATS

For moving heavy loads without using additional loading equipment. One man, truck with winch, and Hobbs Self-Loading Float can do entire job of loading, moving, and unloading.

Trailer front is lowered by winch, forming easy-grade ramp (see photo at top). Truck backed against rear of trailer. Load pulled on with winch or moved on under own power.



After load is in place, truck is moved back to front and trailer lifted back into traveling position by winch. Two types semi-automatic fifth wheel mounting — on truck or inverted under trailer.

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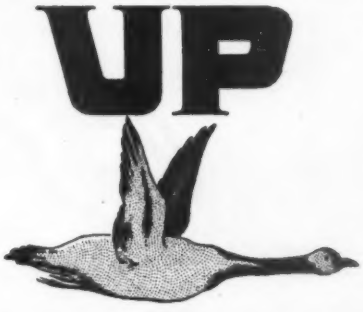

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The realization of the ease of operation, fact-finding rapidity, accuracy and low rental cost of the E-C Inclinometer has increased its use to an amazing extent. Today it stands the leading instrument for determining the course of a bore hole.

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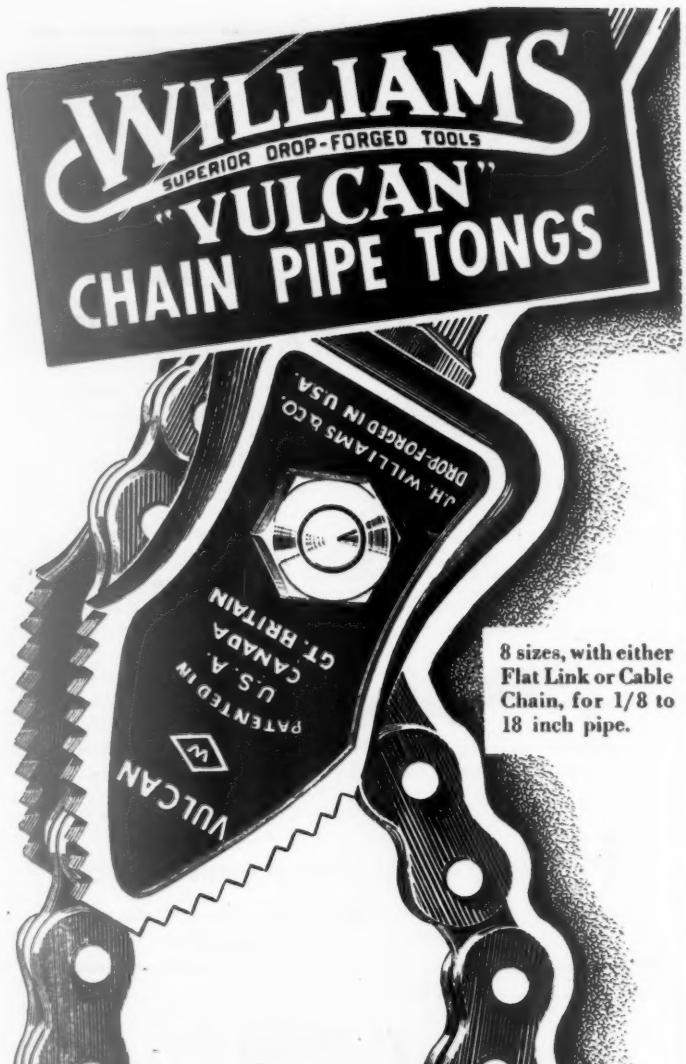
Offices: Philadelphia, Pa.; Houston, Corpus Christi, Marshall, Odessa, Texas; Lafayette, La.; Long Beach, Bakersfield, Calif.; Oklahoma City, Okla.; Casper, Wyo.



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For almost half a century "Vulcan" has been the favorite oil field tong because of its unique ability to "take it." Chains are *proof-tested* and *certified.* Jaws and Handle are tough drop-forgings. Through-bolt is extra heavy and threaded U. S. Standard so nut can be readily replaced. Write for literature, or refer to our advertisement in Composite Catalog.

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Harris president UOP

At a meeting of the board of directors of Universal Oil Products Company, Chicago, David W. Harris of Shreveport, Louisiana, was elected president of the company.

D. W. Harris

Harris for many years has been active in the oil and gas industry. More recently he has been president and general manager of the Arkansas Natural Gas Corporation and prior to that time vice president of Indian Territory Illuminating Oil Company. Harris is a vice president and director of the General Mid-Continent Oil and Gas Association, a director of the American Gas Association, and counsellor of the American Petroleum Institute. In addition to having experience in the oil and gas industry, he is an engineer by training, having graduated in 1912 from the Georgia School of Techonolgy with the degree of bachelor of science.

Joseph G. Alther, who has long been associated with Universal Oil Products Company, has resigned as vice president and director. Alther, however, has agreed to act as a consultant to the company.

Macauley Carter, upon his request, has been relieved of his duties as treasurer and assistant secretary, but is continuing in the service of the company.

Brian R. Muirhead has been elected treasurer of the company to succeed Carter.

Harris stated that the purpose of the management will be to continue the general business and policies of the company as in the past. It is intended, however, to intensify further its research, engineering, and service activities in order that it may be in a position to serve better its licensees under the changed conditions that will be met with in the postwar period, he said.

Harris has been active both in the technical and administrative fields of the oil and gas industries since he was graduated from Georgia School of Technology in 1912. During his 33 years service to the industry he has been director of the budget and assistant treasurer of Cities Service Company, and also since 1928, when Cities Service acquired an interest in the Arkansas-Louisiana-Texas oil and gas properties, he has been vice president, general manager, and later president of the Arkansas Natural Gas Corporation and its subsidiaries.

Harris served as vice president and general manager of the Cities Service Defense Corporation, which built and operated the Maumelle Ordnance Works at Little Rock, Arkansas.

Other positions he has held are treasurer of the Empire Gas and Fuel Company, vice president of Indian Territory Illuminating Oil Company, and president of the Orange State Oil Company.

New G-E research laboratory

A new building for the General Electric Company's research laboratory, which will afford some 50 per cent more space than present facilities provide, will be erected near Schenectady at a cost of $8,000,000, it was announced by President Charles E. Wilson. Construction will begin as soon as WPB approval can be obtained.

The site has been a private estate known as "The Knolls" and includes 219 acres. It is in suburban Niskayuna, about 4½ miles from the main plant and offices at Schenectady.

"The two buildings now occupied by the laboratory were built in 1914 and 1922," said Dr. C. G. Suits, G-E vice president and director of research, "and while they were the last word in laboratory construction then, this is no longer true. For some time we have been cramped for space and this condition has been aggravated in the past few years when all our facilities have been devoted to war work. We have a very much expanded program for the postwar years, which will increase our staff from its present 540 to about 800."

The new building, in the general shape of the letter T, will vary from two to five stories in height and will include 200,000 sq. ft. of laboratory working space in addition to an auditorium seating 300, a dining room, conference rooms, etc. One third of the laboratory space will be devoted to service facilities,

machine shops and specialty shops such as glass blowers, all in a convenient central location.

Walls between rooms will be movable, capable of being placed at 18-in. intervals so that rooms may easily be made large or small as desired. The building will be air-conditioned throughout. Wires and pipes carrying various kinds and voltages of electricity, compressed air, suction, illuminating gas, hydrogen, oxygen, etc., will interlace the building whence they can be brought into any room.

The high elevation of the site above the river will afford many advantages, for example, in experiments with radar, high frequency jet engines. The rocky cliff foundation will be useful in conducting experiments with X-rays. These are being produced at 100 million volts in the present laboratory, and further increases are expected.

New J & L store

The Jones and Laughlin Supply Company has opened a store in Crescent, Oklahoma. Fred Bozeman, formerly at Russell, Kansas, has been transferred to Crescent and made store manager. H. D. Witt, formerly at Perry, Oklahoma, will be connected with the new store.

Crescent is in the northern Oklahoma district of the Jones and Laughlin Supply Company, under district sales manager A. A. Hopper of Bartlesville, Oklahoma.

Reorganizes operations

Schlumberger Well Surveying Corporation has centralized its operations in the Mid-Continent under its Tulsa office and the continued management of R. G. Hamilton with L. A. Allaud as technical assistant. This office will supervise all operations in Oklahoma, Kansas, and the Texas Panhandle. The work in Kansas will be under the supervision of C. K. Ruddick, previously in Oklahoma City where he has been replaced by W. R. Mills.

At the same time, Schlumberger has announced the establishment of two new headquarters. The Florida division has been organized under the management of M. C. Watson with headquarters at Tallahassee. Operations in north Louisiana, East Texas, and Arkansas will, from now on, be under the supervision of R. T. Wade with headquarters at Shreveport, Louisiana.

Manager drilling machinery sales

George W. (Jack) Walton has assumed the post of manager of drilling machinery sales of International Derrick and Equipment Company—one of the Dresser Industries—it is announced by Ferguson Barnes, Ideco general manager of sales.

Walton, a native of Belton, Texas, attended Missouri School of Mines until he joined the Air Service in World War I. His subsequent business career has been almost entirely devoted to oil field equipment. He was associated with the old National Supply Company (both in this country and in London, England), with Wilson Snyder Manufacturing Company, with Emsco as vice president and sales manager, and with Unit Rig and Equipment Company as sales manager. Just prior to joining Ideco, Walton was connected with the development and handled the sales of the new Clark Bros., Inc., mud pump.

Walton is a member of the American Society of Mining Engineers, the American Petroleum Institute, the Nomads (Tulsa Chapter), the Engineers Club, Tulsa, the Tulsa Club, and the Dallas Petroleum Club.

Walton's headquarters are in the Continental Building, Dallas, where he will be assisted by Carl Engelmohr, formerly advertising manager at Ideco's Beaumont plant.

Macwhyte fourth "E" award

For the fourth time since November 21, 1942, the Macwhyte Company, Kenosha, Wisconsin, has been cited for an outstanding achievement in war production with the award of the Army-Navy "E," symbol of excellence.

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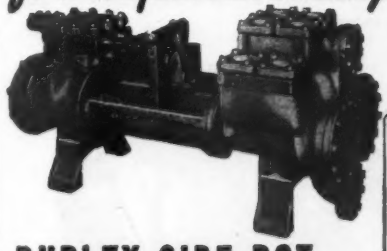

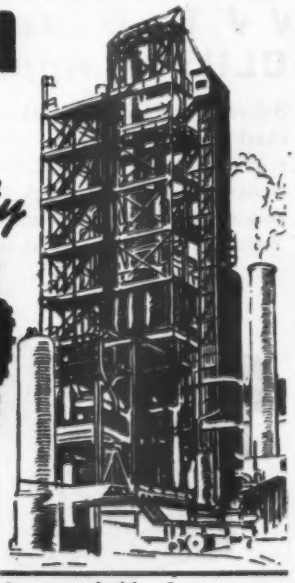

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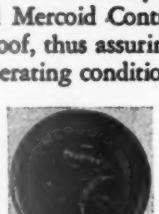

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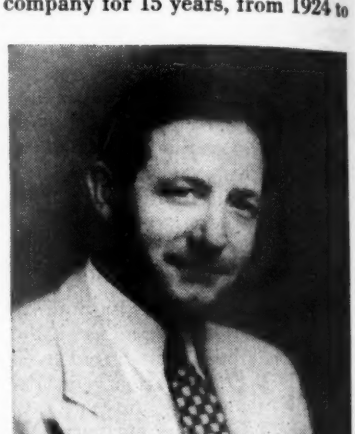
ROCKFORD CLUTCHES

Heads GE air conditioning

G. R. Prout recently was appointed general manager of the air conditioning department of General Electric Company with headquarters at Bloomfield, New Jersey. Prout served in the southwestern district of the company for 15 years, from 1924 to 1929. He left Dallas in September of that year to become manager of sales in the industrial control division with headquarters in Schenectady, New York, and was named manager of the division in July of this year.



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During his 15 years in the southwestern district he served as a motor and industrial control specialist, as well as specialist in electric equipment for the petroleum industry. Many articles written by him about the application of electrical equipment to the several branches of the petroleum industry have appeared in petroleum magazines.

Prout was born at Quincy, Massachusetts, November, 1899, and was graduated from Massachusetts Institute of Technology in 1923 with the degrees of B. S. and M. S. in electrical engineering. He entered the employ of the General Electric Company in the small motor department at Lynn, Massachusetts, in June of that year and was engaged in service engineering and survey work for that department in the New England district until his transfer to the southwestern district, September 1, 1924.

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The Petroleum Administration for War has announced the appointment of E. E. Robbins, of Tulsa, Oklahoma, as director of its Division of Materials. Robbins was formerly a special representative on petroleum materials for the United States Steel Export Company.

The new director replaces Claude P. Parson, of Duncan, Oklahoma, who resigned effective June 5 to resume his duties as vice president of the Halliburton Oil Well Cementing Company of Duncan, from which he was given leave in January, 1944, to serve with PAW.

"The Petroleum Administration for War is extremely fortunate in obtaining as director of its Division of Materials a man so particularly fitted for the task by his previous experience," Deputy Petroleum Administrator Ralph K. Davies said in commenting on the appointment.

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Parsons, who returned to his company after a year and a half with the federal agency, went to PAW as assistant director of the Division of Materials in January, 1944, becoming director the following April. His knowledge of petroleum industry materials is based upon 26 years' experience in the oil business.

After serving in the first world war as a lieutenant and chief test pilot in the U. S. Air Forces at Love Field, Dallas, Texas, Parsons went to work with the Magnolia Petroleum Company of Dallas in 1919 as a roustabout. He worked up to the post of district superintendent for Magnolia in Oklahoma.

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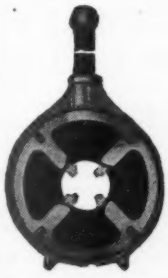

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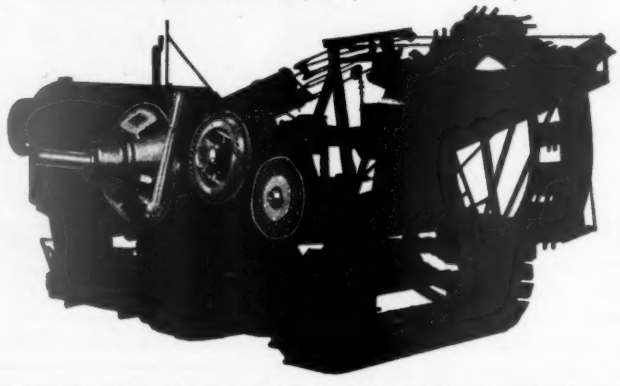

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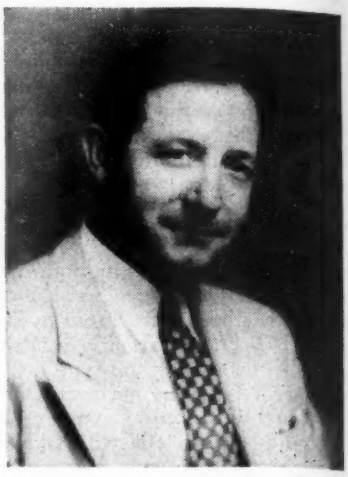

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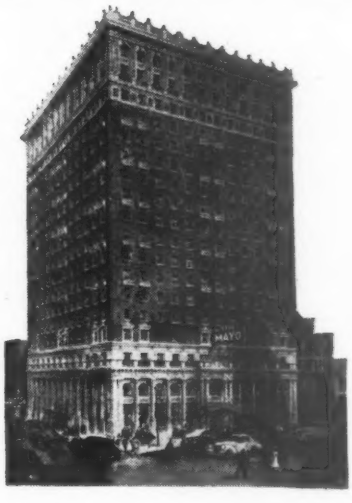

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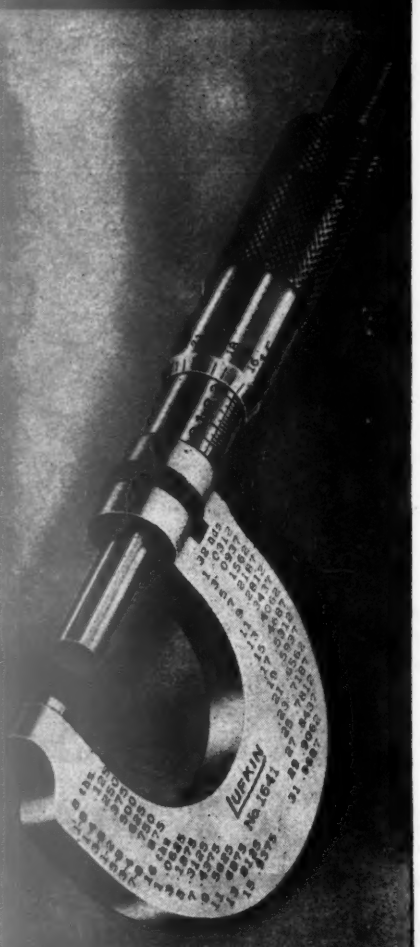

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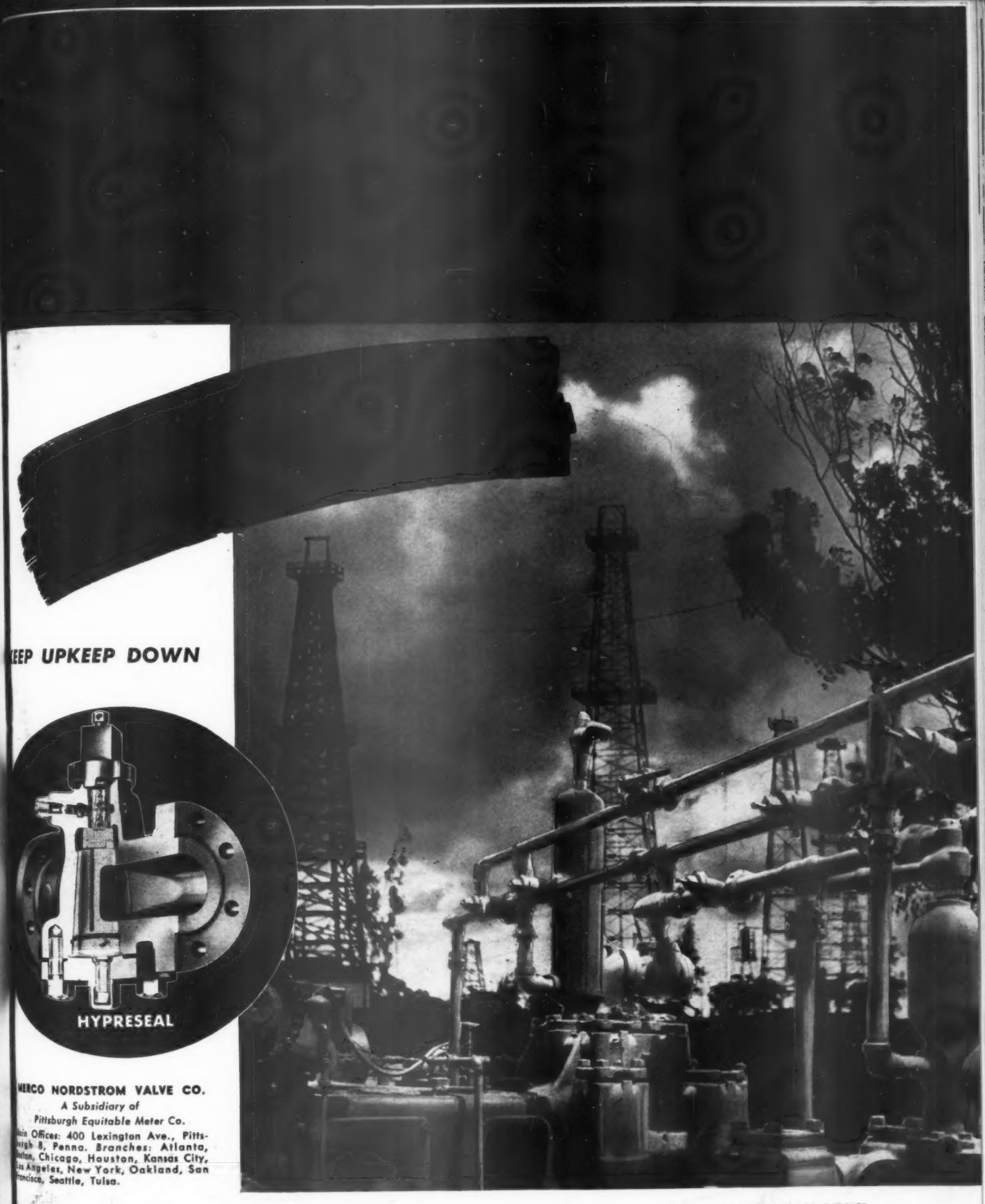

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